T/N 335

TECHNICAL NOTE

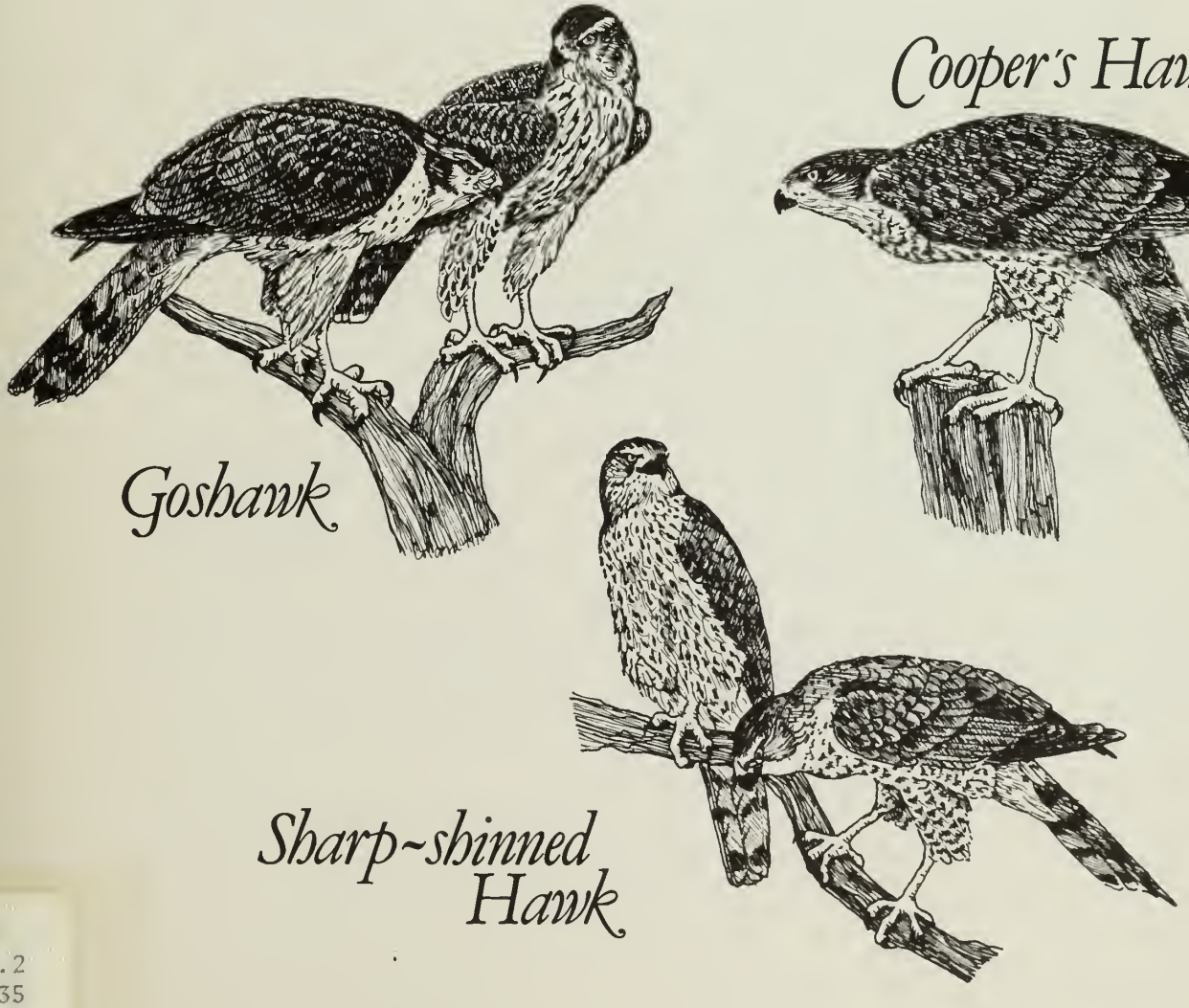
U.S. DEPARTMENT OF THE INTERIOR – BUREAU OF LAND MANAGEMENT

HABITAT MANAGEMENT SERIES FOR UNIQUE OR ENDANGERED SPECIES

Report No. 17

THE ACCIPITERS - Goshawk, Cooper's Hawk, Sharp-shinned Hawk

by Stephen Jones



Frontispiece. Goshawk at nest with young. Photo by Robert J. Erwin.

THE ACCIPITERS

GOSHAWK, COOPER'S HAWK, SHARP-SHINNED HAWK

By

Stephen Jones

Completed under BLM Contract No. YA-530-PH9-159, negotiated under authority of 41 USC 252 (C) (3), COAR: Mayo W. Call.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The objective of this report is to provide land managers with the latest information on unique, threatened or endangered species occurring on the public lands. This will provide a tool for improved understanding of the interrelationships between the species and their environments and encourage an end product of enlightened land management which will consider the species' welfare in all management decisions.

SPECIES DESCRIPTION

The genus *Accipiter*, with 47 species worldwide, comprises the largest genus in the Falconiformes and represents a highly advanced nearly cosmopolitan group of predatory birds. Typically, the species are short-winged, long-tailed forest hawks characterized by secretive breeding habits and very aggressive behavior. Worldwide the genus exhibits many color patterns with very dark forms not uncommon in the tropics and a pure white form occurring in Australia. All species in the genus exhibit a high degree of sexual size dimorphism, with the females being from one-third to as much as 2 times larger than the male (Grossman and Hamlet 1964; Brown and Amadon 1968; Wattel 1973).

In North America there are 3 species of *Accipiter* hawks, the goshawk *(A. gentilis)*, sharp-shinned hawk *(A. striatus)* and Cooper's hawk *(A. cooperii)*. The goshawk is polytypic, with 9 subspecies worldwide (North America, Europe and Asia) and 3 in North America. The dominant form, *A. g. atricapillus*, occurs over most of the mountainous United States, including Alaska, and boreal Canada. A similiar, but slightly darker race, *A. g. laingi*, is resident in the Pacific Northwest up to Alaska. The "apache" goshawk, *A. g. apache* is found in southern Arizona and Mexico (Brown and Amadon 1968). The American Ornithologist Union (1957) recognizes only 2 races of *A. gentilis*, *A. g. atricapillus* and *A. g. laingi* for North America.

Ten races of the sharp-shinned hawk are found in North, Central and South America. The United States hosts 3 races. The most common, *A. s. velox*, is resident throughout the United States and is a summer resident in Alaska and Canada. Like the goshawk, there is a race of sharp-shinned hawk, *A. a. perobscurus* found in upper Washington and British Columbia, and a third slightly larger race, *A. s. suttoni*, occurring in southern Arizona, New Mexico and south into Mexico. There is some speculation as to whether the birds in Arizona and New Mexico are actually of the *suttoni* race, or whether they represent an intergrade between *velox* and the population of *suttoni* in Mexico (Storer 1952; Brown and Amadon, 1968).

The Cooper's hawk is monotypic, there being only 1 form, *A. cooperii*, and it is found only in the United States, southern Canada, and northern Mexico. There does appear to be a gradual size increase from north to southwest, but the differences in the 2 extremes are not great enough to warrant subspecies classification. Early taxonomists (see Friedman 1950) classified *A. cooperii* into 2 races, the eastern *A. c. cooperii*, and the western *A. c. mexicanus*. This designation has subsequently been dismissed, although the differences between the eastern and western birds can be striking. The Gundlach's hawk *(A. gundlachi)* was, as originally classified, a subspecies of *A. cooperii*.

The goshawk, sharp-shinned hawk and Cooper's hawk resemble each other in shape and overall gross plumage characteristics, but differ markedly in size. The diminutive male sharp-shinned has only one-fourth the wing length and one-tenth the weight of the female goshawk. The young of each species is born with short creamy-white down, sometimes yellowish in *A. striatus*. This down is then replaced by longer, woolier down, tinged with grey, as the flight and body feathers begin to develop. The back and head feathers are the last to emerge. The young usually leave the nest before the flight feathers are fully developed and with down still on their back and head. For goshawks this time would be at about 35-40 days old, for sharp-shinned hawks 23 days old and for Cooper's hawks 27-30 days old. Young accipiters normally have grey to bluish-grey eyes at birth which turn amber or yellow shortly and remain that color until the next spring and the onset of the first moult at which time they begin a gradual yearly transition from yellow to orange to red (Bent 1937; Brown and Amadon 1968). Adult goshawks attain mahogany-colored eyes.

Juvenile sharp-shinned hawks *(A. s. velox)* are brownish above, the feathers edged in light brown. These feather tips grade into rufous on the rump and adjacent upper wing coverts. Underneath, the young appear base dull white, heavily streaked with teardrop shaped spots of brown to red-brown color, the females being more red-brown and the lower breast being more red-brown. The bill is pale bluish with a black top, greenish-yellow eyes and legs yellow. The tail is a light beige with 3 to 5 visible dark brown bands. The tip of the tail is edged with a narrow tip of grey or white. The primaries are off white from below with dark brown transverse stripes. Both sexes are alike in this plumage, although quite different in size.

Sharp-shinned hawks go through the first moult and acquire the adult plumage when a little over one year old. The eye color begins to change in the first spring to orange and the fully red eye is acquired in 3 to 4 years. Second year birds can be identified by the orange-colored eye and incomplete moult on the rump and lower back, i.e., the presence of brown feathers with rufous tips. (Note: Adult rump and back feathers are brownish after a year's wear, especially in the female. Thus, the presence of the rufous tips is necessary to determine second year birds in their first adult plumage.) Some individuals' subsequent adult moults are likewise incomplete. In this adult plumage the birds are blue-grey above, with the top of the head being the same color as the back. Females are duller and browner. Iris color goes to bright red with black bill and yellow legs. (Bent 1937; Brown and Amadon 1968; Beebe 1974).

Male sharp-shinned hawks, *A. s. velox*, average 107 grams in weight and females 179 grams. The wing length ranges from 161-178 mm

for males and 191-206 mm for females. *A. s. perobscurus* is of the same size as *velox* but differs in being slightly darker, most noticeably in the juveniles. The adult plumage is similar to the sharp-skin but the top of the head is black. The tail is light beige with 3 to 5 dark brown bars and has a bluish cast. *A. s. suttoni* averages larger than *velox*, with wing measurements of 170-192 mm for males and 216-229 mm for females. *A. s. suttoni* is also generally paler but with more evenly rufous thighs than *velox*. The size increase from *velox* to *suttoni* continues southward to the subspecies of *striatus*, *A. s. madrensis*, in Central America (Storer 1955, 1966; Craighead and Craighead 1956; Brown and Amadon 1968).

The Cooper's hawk is very similar in all plumages to the sharp-shinned hawk. Juvenile Cooper's hawks differ slightly from young sharp-shinned hawks in that the breast is washed with cinnamon, although this normally fades as the season progresses. At 1 year of age the young acquire a sub-adult plumage and then the full adult plumage at the second moult. The adult plumage is similar to the sharp-shin but the top of the head is black. The tail is light beige with 3 to 5 dark brown bars and has a bluish cast. Adult Cooper's have shorter wings and tails than the juveniles, the difference being about 2 mm (Brown and Amadon 1968).

Male Cooper's hawks weigh an average of 380 grams and females 560 grams. Wing lengths are 214-238 mm for males and 247-278 mm for females. As individual birds can show considerable variation in size, male Cooper's hawks are often confused with female sharp-shins in the field. Overhead, the 2 are separable by the rounded tail of Cooper's hawks and the square ended tail of sharp-shinned hawks - male sharp-shinned hawks have a slightly notched tail. Cooper's hawks also have a noticeably larger head, which protrudes much farther from the leading edge of the wing than in the sharp-shin. Also, the tail of the Cooper's hawks is distinctly white tipped early after the moult. Sitting birds of both species are usually distinguishable by size. Similarly, the female Cooper's may sometimes be confused with a male goshawk. Here, the situation is minimized by the fact that these 2 species only infrequently occur together. At close range the adult goshawk is seen to have a prominent white eyestripe. In flight, Cooper's hawks have a more conspicuously barred tail and wings than goshawks, and are generally browner (Bent 1937; Storer 1966; Brown and Amadon 1968; Beebe 1974).

The goshawk is the largest North American accipiter and is about the size of the common raven *(corvus corax)*. Juvenile goshawks are much lighter looking than the other 2 because of much light brown and white spotting in the back feathers. The breast is streaked very nearly like the Cooper's. However, juvenile goshawks are more cinnamon underneath and the adult plumage differs considerably from that of Cooper's or sharp-shins. Adult goshawks *(A. g. atricapillus)* are slate or bluish-grey on the back and the head is black except for the white eye-stripe. The underparts are finely stippled with grey and white, with narrow shaft streaks. The tail is light brown or grey with 4 to 5 dark brown stripes. Adult goshawks are heavier and longer-winged and tailed than juvenile goshawks (Clark, pers. commun.).

Male *A. g. atricapillus* weighs about 860 grams and have wing lengths of 309-338 mm while females average 1,100 grams and 339-374 mm wing lengths. For the goshawk, as well as the other species, extreme individual variation can exist in physical measurements, especially weight. Alaskan birds tend to be heavier than the more southerly birds, averaging 1,200 grams for females. Individuals of *A. g. laingi* are of similiar size to those of *atricapillus* but darker in plumage, most noticeably in the juveniles. Few specimens of *A. g. apache* have been collected. Wing lengths from 2 males were 344, 354, and from 3 females, 365-390 (Craighead and Craighead 1956; Storer 1966; Brown and Amadon 1968; McGowan 1975).

The name *Accipiter* is derived from the Latin "accipere" meaning to take or seize, describing the general predatory nature of all species in the family Accipitridae. There is some confusion as to why the name goshawk. Consensus of opinion suggests that it came from "goose hawk". "Gentilis" is Latin for gentle or noble. (Only the gentry or noblemen were allowed to fly the goshawk for falconry.) The sharp-shinned hawk is so named because of its featherless tibia, or shin bone, which is feathered in the other species. "Striatus" is Latin for striated or striped, referring to the striped patterning on the bird's tail. The Cooper's hawk was named for the American zoologist William Cooper (1798-1864) of the founders of the New York Lyceum of Natural History (Gruson 1972). All 3 accipiters are sometimes called "chicken hawks" because of their notorious appetite for these fowl. Adult Cooper's and sharp-shinned hawks are often coined "blue darters" alluding to their color and hunting habits.

PRESENT AND FORMER DISTRIBUTION

Collectively, the 3 accipiters are distributed throughout the United States and Canada and races of *striatus* extend down into Middle and South America. The sharp-shinned hawk enjoys the widest distribution in North America, sharing with goshawks the boreal forest and mixed woodlands of Canada and Alaska, and with Cooper's hawks the evergreen forests and deciduous woodlands of the contiguous United States. In winter all 3 species are found throughout most of the United States.

Figure 1 illustrates the distribution of the goshawk *(Accipiter gentilis spp.)* in North America. *A. g. atricapillus* breeds from northwestern Alaska (Kobuk River), northwestern Mackenzie, northern Alberta, northern Saskatchewan, Ontario, Quebec, Labrador, and Newfoundland south to California (Sequoia National Park), Nevada (Charleston and Sheep Mountains), southeastern Arizona, Colorado, northern Minnesota, Michigan (to Roscommon County), Pennsylvania, and western Maryland; and in Jalisco. The wintering range extends from western and central Alaska, British Columbia (Cariboo district), Saskatchewan, Ontario, Quebec, and Newfoundland south to southern California (San Diego), Jalisco (Mexico), Texas, Missouri, Tennessee, Kentucky, West Virginia, and Virginia. It also occurs casually in Florida (A.O.U. 1957; Godfrey 1966). The subspecies *laingi* breeds and is probably resident on Vancouver Island, the north coastal islands of British Columbia and southeastern Alaska (Taverner 1940; A.O.U. 1957).

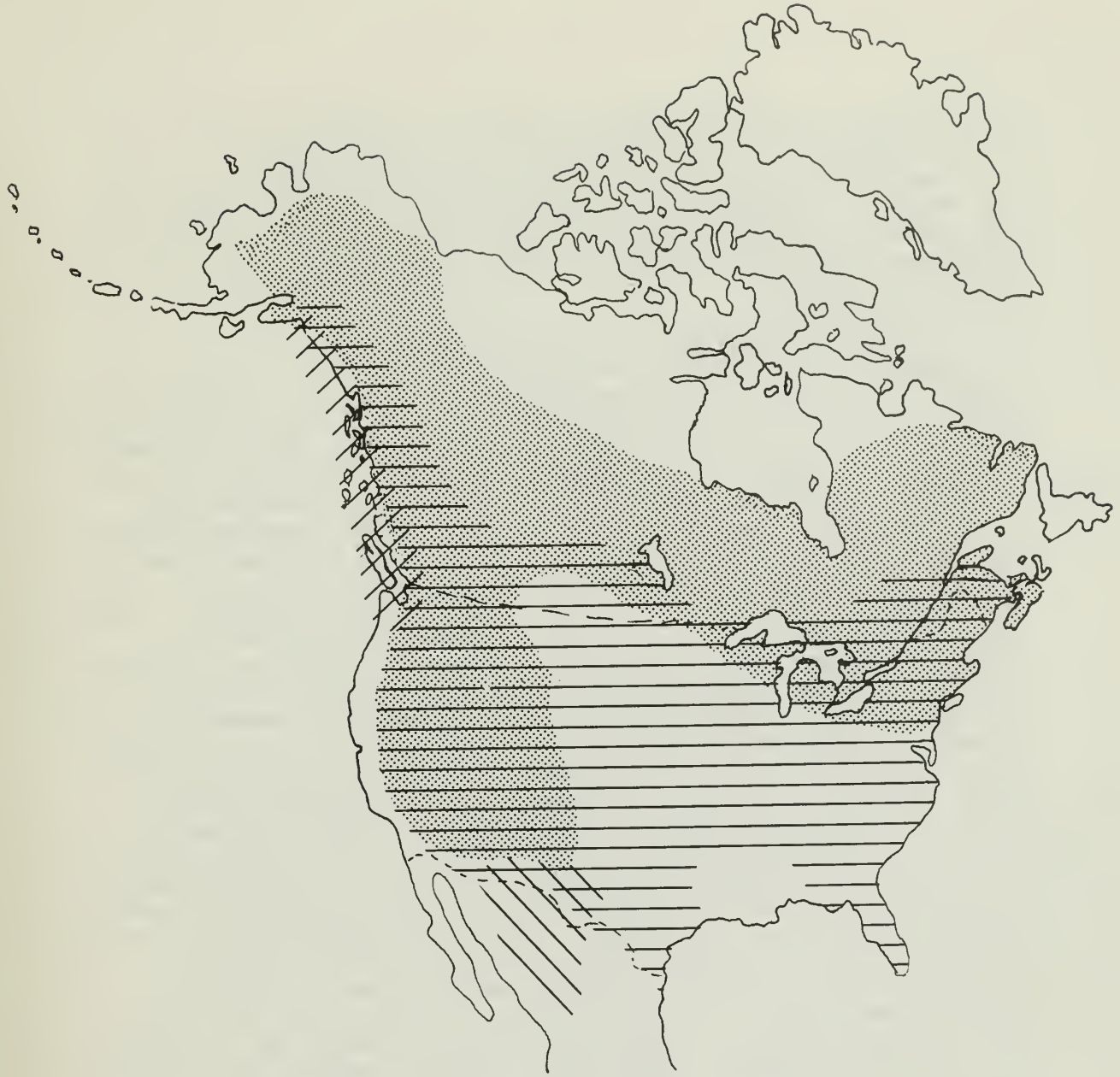


Figure 1. Distribution of the Goshawk (Accipiter gentilis spp.) in North America.

A. g. atricapillus -- Breeding Range

A. g. atricapillus -- Wintering Range

A. g. laingi -- Breeding and probable Wintering Range

A. g. apache -- Breeding and probable Wintering Range

A. g. apache is found in southern Arizona, New Mexico and the mountains of northwestern Mexico (Brown and Amadon 1968).

The distribution of the goshawk has changed little in the North and West. In the eastern states goshawks were much more common before the demise of the passenger pigeon around 1900. In the 1800's the goshawk was apparently common throughout the Northeast and as far south as Kentucky, with scattered records existing for Louisiana (Bent 1937; Mengel 1965).

The sharp-shinned hawk is abundant, but uncommonly seen throughout the United States except the extreme Southeast, and Canada. Figure 2 illustrates the distribution of the sharp-shinned hawk *(Accipiter striatus spp.)* in North America. The American Ornithologist's Union (1957) records the range of the sharp-shinned hawk as follows: *A. s. velox* breeds from northwestern Alaska (Kotzebue Sound), Yukon, northwestern Mackenzie (Great Bear Lake), northern Saskatchewan, central Manitoba, northern Ontario, central Quebec, southern Labrador, and Newfoundland south to California (Monterey County; San Bernadino Mountains), Arizona, New Mexico, Texas (Texarkana, Edinburg), Louisiana, Tennessee, South Carolina, and Alabama (Greensboro). The wintering range extends from southern British Columbia, western Montana, Nebraska, southern Minnesota (casually), Illinois, southern Michigan (rarely), southern Ontario (casually), New York, southern Vermont, southern New Hampshire, southern Maine, New Brunswick (casually), and Nova Scotia south to the Gulf coast, southern Florida (Lake Okeechobee), and through Mexico and Central America to Costa Rica, casually to Panama. The North Coast sharp-shinned hawk, *A. s. perobscurus*, breeds in the Queen Charlotte Islands and possibly also in the northwest coastal areas from Yakutat Bay, Alaska, south to the Olympic Penninsula of Washington (Neah Bay). A slight southerly movement is evident, as the wintering range of *perobscurus* includes the Queen Charlotte Islands to Vancouver Island (Comos, Cedar), and on the mainland from central British Columbia (Hazelton, Rainbow Mountains) south to Oregon (Tillamook and Portland). The Mexican sharp-shinned hawk *(A. s. suttoni)* breeds from the east side of the San Luis Mountains on the New Mexico-Chihuahua border south through the highlands of Mexico to Michoacan, Jalisco, Coahuila, and Veracruz. *A. s. suttoni* winters in the lowlands of its breeding range, and southward.

While regional populations of the sharp-shinned hawk may have declined from years past, there is no evidence to suggest that the species distribution has changed appreciably. In the contiguous United States, the Cooper's hawk is the most common breeding accipiter. Portions of Texas, Georgia, and Florida are the only areas without a breeding complement of Cooper's hawks. Over much of its range, the Cooper's hawk is resident year round. There is a slight movement southward out of Canada and the northern prairie states and into Mexico (Figure 3).

The A.O.U. (1957) records the Cooper's hawk as breeding from southern British Columbia, central Alberta, northwestern Montana, Wyoming, eastern North Dakota, southern Manitoba, western Ontario, northern Michigan, southern Ontario, southern Quebec, Maine, northern

Figure 2. Distribution of the Sharp-shinned Hawk (Accipiter striatus spp.) in North America.

A. s. velox -- Breeding Range

A. s. velox -- Wintering Range (Also to Cuba)

A. s. perobscurus -- Breeding and Wintering Range

A. s. suttoni -- Breeding and Wintering Range

Figure 3. Distribution of the Cooper's Hawk (Accipiter cooperii) in North America

New Brunswick (Restigouche Valley), Prince Edward Island, and Nova Scotia south to Baja California, Sonora, Chihuahua, south-central Texas (Kerrville), Louisiana, central Mississippi, central Alabama (Greensboro), and central Florida (Orlando Manatee). The wintering range is listed as Washington, Colorado, Nebraska, Iowa, southern Wisconsin (rarely), southern Minnesota, southern Michigan, southern Ontario (casually), New York, Vermont (casually), southern Maine, and Massachusetts (Taunton, rarely) south throughout the United States and Mexico to Costa Rica. Imhof (1976) records the Cooper's hawk as a common breeder throughout Alabama.

Similar to the sharp-shinned hawk, there is no evidence of a change in the distribution of Cooper's hawks over past years but some regional populations have undergone declines.

STATUS AND POPULATION TRENDS

Within their respective ranges, the 3 accipiters are regular, if uncommon, breeders. None of the species has been considered endangered or threatened.

Populations of goshawks and sharp-shinned hawks have been little studied compared with those of Cooper's hawks. What limited information is available suggests that the goshawk is stable over its range and rather abundant in certain areas. McGowan (1975) found the goshawk common in interior Alaska, yet fluctuating considerably in numbers from year to year as a result of changing prey densities. Shuster (1977) observed goshawks nesting in high densities in the Rocky Mountains of northern Colorado.

Figure 4 (Nagy 1977) illustrates the population trends for the 3 accipiters as gleaned from annual migration counts at Hawk Mountain, Pennsylvania. Exact interpretation of such graphs is difficult but general trends are evident. Goshawks have remained relatively stable in numbers except for dramatic fluctuations occurring at fairly regular intervals. These fluctuations are related in part to changing conditions on their northerly breeding grounds (Mueller et al. 1977). Both the Cooper's hawk and the sharp-shinned hawk show gradual declines in numbers seen since about 1947, the year use of DDT became common. Snyder et al. (1973) show that for both species the percent of total hawks seen at Hawk Mountain is significantly lower for years from 1947 onwards than for pre-1947 years. The increase in numbers of sharp-shinned hawks after 1970 may indicate that the population is beginning to recover from any pesticide-induced decline.

Henny and Wight (1972) examined 300 nesting records and the available banding records to document trends in populaton parameters of the Cooper's hawk in the northeastern United States. The specific mortality rates and production requirements should be regarded as provisional (small sample size), although the long-term patterns appear obvious. They suggested that Cooper's hawks in the northeastern United States suffered excessive post-fledgling mortality

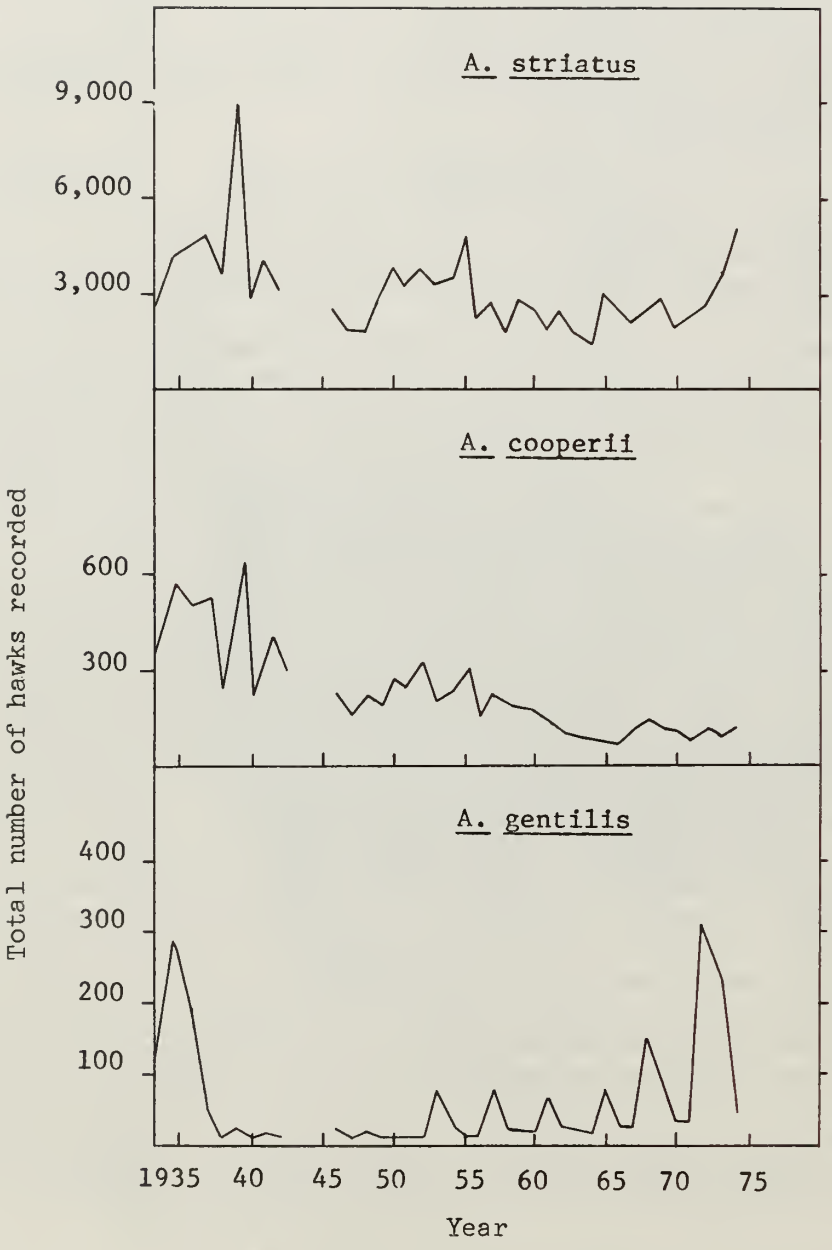


Figure 4. Population trends of North American accipiters as revealed from migration counts at Hawk Mountain Sanctuary, Pennsylvania. From Nagy, 1977. Breaks in curves correspond to the date of widespread introduction of DDT into agricultural use.

prior to 1940, probably due to high shooting losses. The shooting of Cooper's hawks (as evidenced by the first-year band recovery rate of shot birds) has become a less serious problem during recent years. However, beginning during the period 1946-48 reduced productivity became a more serious problem (Henny and Wight 1972). Production decreased even further during the years 1949-67, but improved more recently 1968-74 (Braun et al. 1977).

In the West the Cooper's hawk population appears stable. Walton et al. (1976) found the Cooper's hawk common in the coastal ranges of California and reproducing at rates comparable to historic rates. In Utah all accipiters are still common, although Cooper's hawks are less so than previously (White 1969). Snyder et al. (1973) reported on the accipiters in Arizona and New Mexico from 1969 through 1971. Cooper's hawks were regular breeders on their study area and the population was stable during those years. There had apparently been no reduction in numbers of Cooper's hawks on the study area since 1961.

Few data exist on the regional status or population trends for sharp-shinned hawks other than the numbers counted on migration. Beebe (1974) felt that the sharp-shinned hawk was extremely abundant, presumably on its northern breeding grounds. Godfrey (1966) also listed the sharp-shinned hawk as a common breeder for Canada. Gabrielson and Jewett (1940) consider the sharp-shinned hawk a common permanent resident in Oregon.

LIFE HISTORIES

Hunting Methods

The accipiters differ in their specific hunting techniques, but all possess the abilities of extremely rapid flight over short distances, skilled maneuverability in flying through dense cover, and extreme aggressiveness in the pursuit of prey. The accipiters can accurately be described as consistently opportunistic hunters.

The goshawk, largest of our accipiters, is also the most cunning and bold predator of all North American birds of prey. Goshawks typically hunt dense woodlands, clearings and open fields. When aware of potential prey, the goshawk will wait until the prey appears unaware or is far from cover and then will approach as quickly and secretively as possible. If unseen, the hawk will capture its quarry and carry it off with little more than a delayed wingbeat, depending of course on the size of the prey. Aerial pursuits are common, since many of the avian prey species are very alert. The goshawks' speed is tremendous over short distances up to about 1 kilometer and most quarry flushed at short range are captured. Reckless, and very persistent in hunting, goshawks will crash into bushes after birds or rabbits and then walk on the ground to reflush the prey; they are not averse to going into water after prey. One goshawk in the Sierra Nevada Mountains was observed walking and hopping around a small lake for more than an hour in search of mallard ducklings, of which it eventually caught 3 (Bent 1937; Alexander 1947; Schnell 1958; Storer 1966; Brown and Amadon 1968; Beebe 1974).

In his study of habitat and time utilization of a pair of sharp-shinned hawks in Utah, Platt (1973) repeatedly observed 3 methods of hunting by this species. The most variable was what Platt called the "prospect flight". The hawk would leave its perch, make a few low gliding traverses along a hillside or over a ravine and then land on a different perch. The second method observed was that of still hunting. The hawk perched in thick cover and waited for unsuspecting birds to fly by, and then would make quick dashes out at opportune moments. The third method, speculative hunting, involved the adult flying just above the ground at a flat rate of speed on open hillsides. This hunting technique closely resembles that of the marsh hawk *(circus cyaneus)*. Sharp-shinned hawks will occasionally hunt flocks of birds from high in the air, and in this way differ from either goshawks or Cooper's. In California, a sharp-shinned hawk was seen to imitate the gliding flight of a scrub jay, an undulating flight paralleling the ground, to approach a small shrub containing sparrows. The sharp-shinned hawk, and also the other accipiters, will often harass and pursue birds much larger than themselves. Sharp-shinned hawks seldom catch quarry off a perch and aerial chases are the rule. In tight cover, they are the most agile of raptors and will often catch their prey deep within foliage.

The Cooper's hawk will utilize most of the hunting techniques described above, and is like the goshawk in most aspects of its hunting. Cooper's hawks are most often found still hunting in a riparian type habitat, waiting for an unexpecting victim to venture far enough from cover to allow for attack. As with the other accipiters, the Cooper's hawk always utilizes the element of surprise in its hunting. The Cooper's hawk will frequently land on the ground and search out prey it has heard or has flown to cover. Once the prey is flushed, the hawk will immediately resume chase, and repeat this action as long as the prey is nearby. Although unclear of its purpose, Berger (1957) reports on a peculiar type of flight in migrating Cooper's hawks, termed "nighthawk flapping," that is much like the version of the circinine hunting flight of sharp-shinned hawks described above. Cooper's hawks and goshawks have been seen to make strikes on prey with just one foot (Goslow 1971).

Immature accipiters are more open in their hunting and less prudent than the adults. This is probably related to their inexperience, and it appears that the older a bird gets the more patient it becomes in hunting and the more it learns to rely on surprise. Young accipiters may practice hunting in association with their siblings during the post-fledging period. Mailliard (1908) reports on a pair of Cooper's hawks (most probably immature) working together in their attack of a flock of crows.

The accipiters appear to be particularly keen and attracted to oddities or unusual behavior in their prey. Such noticeable conditions would include young birds just out of the nest, injured or weakened animals, and adult male birds actively engaged in courtship behavior and thus totally oblivious to their surroundings. Eng and Gullion (1962) found that 63% of the banded ruffed grouse taken by the goshawks on their study area were males active in drumming activity centers. The taste for young and helpless birds often leads accipiters into nest robbing. Nelson (1968) watched a Cooper's hawk in British Columbia capture a nestling robin directly out of the nest. Meng (1959) observed a Cooper's hawk bring 2 live scarlet tanager nestlings to its nest for the young Cooper's hawks. Hamerstrom and Hamerstrom (1951) reported that of 155 items in the diet of Cooper's hawks, only 25.1% birds of known age were adult; 74.9% were immatures and at least 8.4% of these were nestlings. Of the mammals taken, 21.4% were adults and 78.6% were immatures. The availability of young birds and mammals to nesting accipiters may be a determining factor in the timing of the breeding season and the success of a nesting pair. When the young hawks are growing at their fastest rate, a great amount of easily obtainable prey is needed. Sulkava (1956) showed that goshawks in Europe prey upon adult birds during the nest building and incubation periods, and predominantly young birds during the period of juvenile development.

Each of the accipiters seems to possess what Bond (1942) called the killing reaction. After prey has been caught, accipiters will react violently to any movement of the prey by strongly grasping the prey, relaxing their grip and then clamping down again. Some wild accipiters learn that the sound of a gun usually means injured animals and they may come close at the sound of the shot. Norris (1942) watched a Cooper's hawk seize a crippled coot out of the air only seconds after the coot had been shot and before it fell into the water. Nash (in Anonymous 1971) states that a sharp-shinned hawk once glanced past his head and snatched up a shot plover, before the report of the gun had died.

Once prey is caught, accipiters will typically grab and hold on to the head of the prey and immediately begin to pluck it or pull the fur out. Often, this plucking takes place before the prey is completely dead, and may be what ultimately kills the prey. Accipiters have also been observed drowning their prey (Davis 1948). Nesting accipiters may have from 1 to several "plucking perches" to which they consistently take their prey for plucking. Such perches may be a fallen log or stump, and are located relatively close to the nest. Normally the first part of the prey eaten is that which shows the first blood, usually the head. When feeding, accipiters will tear small bits of meat from their prey and then swallow them. While feathers are avoided, beaks, legs and small bones covered with bits of meat are readily swallowed.

Food Habits and Requirements

Tables 1, 2, and 3 list representative food items of the goshawk, sharp-shinned hawk, and Cooper's hawk, respectively, in North America. Species with an asterisk are those found by one or more authors to be important prey species in various geographic areas. Storer (1966) recorded at least 53 genera of prey species for goshawks, 51 genera for Cooper's hawks, and 81 genera for sharp-shinned hawks. If a list of all prey species recorded for the accipiters were compiled, it might contain up to 30-35% of all birds in North America.

Storer (1966) discussed the inverse relationship between the size of the predator and the numbers and diversity of its prey. Generally, the larger the predator, the less diverse and less numerous its prey species. Regarding accipiters, Storer pointed out that 25 species made up 44% of the diet of sharp-shinned hawks, compared to 6 species making up 71% of the diet of goshawks and 7 species making up 36% of the diet of Cooper's hawks. As evident from this and from Tables 1, 2, and 3, accipiters utilize a wide variety of species as prey, but that only a relatively few species play significant roles in the birds' diets. Hamerstrom and Hamerstrom (1951) reported that for Cooper's hawks they studied *the prey species most commonly taken were not the species most common in the nesting area. The hawks were flying considerable distances to other areas in search of large numbers of these prey.*

The relative percentages of prey items in the diet of the accipiters will vary between species and between pairs of a given species. Generally, sharp-shinned hawks are strictly bird predators; goshawks are equal bird and mammal predators; and Cooper's hawks are most often bird predators but show occasional preferences for mammals or reptiles. Table 4 presents the published figures on the relative makeup of the diets of accipiters. The results of different food habits studies are not always comparable. Most early authors simply relied on the prey items found at or near the nesting site. Snyder and Wiley (1976) have shown that for accurate information on the food habits of a species, observations must be made of the adults bringing prey items to the nest, or actually in the capture of prey. They point out that very small birds, lizards and insects brought in by the adults would not be detectable at plucking perches or in remains at the nest. Summarizing the data in table 4, the diet of goshawks averages 53.8% birds, 37.0% mammals, and 9.1% invertebrates (insects); the diet of Cooper's hawks averages 66.8% birds, 22.2% mammals, 8.9% lower vertebrates (reptiles, and rarely amphibians), and 2.1% insects; and the diet of sharp-shinned hawks averages 93.1% birds, 2.0% mammals, 0.6% lower vertebrates, and 4.2% insects.

Certain individuals or pairs will develop preferences for specific prey items and this can also affect comparison of food habits studies. Fitch et al. (1946) observed a pair of Cooper's hawks in California that preyed predominantly on lizards. Reptile predation by accipiters is probably more common in the West than the East.

Table 1. Representative prey species of the goshawk *(Accipiter gentilis)* in North America[1].

BIRDS

Mallard *Anas platyrhynchos*
Blue-winged Teal *Anas discors*
American Kestrel *Falco sparverius*
Blue Grouse *Dendragapus obscurus*
*Ruffed Grouse *Bonasa umbellus*
Willow Ptarmigan *Lagopus lagopus*
*Bobwhite *Colinus virginianus*
*Ring-necked Pheasant *Phasianus colchicus*
Band-tailed Pigeon *Columba fasciata*
Domestic Pigeon *Columba livia*
Common Nighthawk *Chordeiles minor*
Common Flicker *Colaptes auratus*
Pileated Woodpecker *Dryocopus pileatus*
Blue Jay *Cyanocitta cristata*
Steller's Jay *Cyanocitta stelleri*
*Common Crow *Corvus brachyrhynchos*
*Robin *Turdus migratorius*
Yellow-rumped Warbler *Dendroica coronata*
*Blackbirds *Agelaius sp., Euphagus sp., Quiscala sp.*
Savannah Sparrow *Passerculus sandwichensis*

MAMMALS

California Mole *Scapanus latimanus*
Belding Ground Squirrel *Citellus beldingi*
*Arctic Ground Squirrel *Citellus undulatus*
*Golden-mantled Squirrel *Citellus lateralis*
Eastern Chipmunk *Tamias striatus*
*Townsend Chipmunk *Eutamias townsendi*
Eastern Gray Squirrel *Sciurus carolinensis*
*Red Squirrel *Tamiasciurus hudsonicus*
*Chickaree *Tamiasciurus douglasi*
Flying Squirrel *Glaucomys sp.*
Boreal Redback Vole *Clethrionomys gapperi*
*Snowshoe Hare *Lepus americana*
*Eastern Cottontail *Sylvilagus floridanus*
Mountain Cottontail *Sylvilagus nuttali*

1. Not all prey species reported in literature are listed. Sources for food habits data are: Claybaugh (1932), Bent (1937), Bond (1940), Ingles (1945), Alexander (1947), Schnell (1958), Ammann (1959), Meng (1959), Eng and Gullion (1962), Storer (1966), Snyder et al. (1973), and Snyder and Wiley (1976).

*Those species found to be important prey items, making up a significant portion of the diet of goshawks from different areas.

Table 2. Representative prey species of the sharp-shinned hawk *(Accipiter striatus)* in North America[1].

BIRDS

Blue Grouse *Dendragapus obscurus*
Mourning Dove *Zenaidura macroura*
Swift *Aeronautes sp.*
Yellow-bellied Sapsucker *Sphyrapicus varius*
Flycatcher *Empidonax sp.*
Horned Lark *Eremophila alpestris*
*Tree Swallow *Iridoprocne bicolor*
Jay *Cyanocitta sp.*
Black-capped Chickadee *Parus atricapillus*
Nuthatch *Sitta sp.*
Brown Creeper *Certhia familiaris*
Long-billed Marsh Wren *Telmatodytes palustris*
*Catbird *Dumetella carolinensis*
*Robin *Turdus migratorius*
Hermit Thrush *Hylocichla guttata*
Eastern Bluebird *Sialia sialis*
Kinglet *Regulus sp.*
*Starling *Sturna vulgaris*
Solitary Vireo *Vireo solitarius*
Yellow Warbler *Dendroica petechia*
Yellow-rumped Warbler *Dendroica coronata*
Ovenbird *Seiurus aurocapillus*
Yellowthroat *Geothlypis trichas*
*House Sparrow *Passer domesticus*
Meadowlark *Sturnella magna*
Red-winged Blackbird *Agelaius phoeniceus*
House Finch *Carpodacus mexicanus*
*Rufous-sided Towhee *Pipilo erythrophthalmus*
Vesper Sparrow *Pooecetes gramineus*
*Dark-eyed Junco *Junco hyemalis*
*Song Sparrow *Melospiza melodia*

1. Not all prey species reported in literature are listed. Sources for food habits data are: Bent (1937), Munro (1940), Storer (1966), Platt (1973), Snyder et al. (1973), and Snyder and Wiley (1976).

*Those species found to be important prey items, making up a significant portion of the diet of sharp-shinned hawks from different areas.

Table 3. Representative prey species of the Cooper's hawk *(Accipiter cooperii)* in North America[1].

BIRDS

Ruffed Grouse *Bonasa umbellus*
*Bobwhite *Colinus virginianus*
*California Quail *Lophortyx californicus*
*Ring-necked Pheasant *Phasianus colchicus*
American Coot *Fulica americana*
Killdeer *Charadrius vociferus*
Spotted Sandpiper *Actitis macularia*
*Domestic Pigeon *Columba livia*
*Mourning Dove *Zenaidura macroura*
Yellow-billed Cuckoo *Coccyzus americanus*
Screech Owl *Otus asio*
White-throated Swift *Aeronautes saxatalis*
*Common Flicker *Colaptes auratus*
Pileated Woodpecker *Dryocopus pileatus*
*Acorn Woodpecker *Melanerpes formicivorus*
Eastern Kingbird *Tyrannus tyrannus*
Purple Martin *Progne subis*
*Blue Jay *Cyanocitta cristata*
Mexican Jay *Aphelocoma ultramarina*
Tufted Titmouse *Parus bicolor*
White-breasted Nuthatch *Sitta carolinensis*
Brown Thrasher *Toxostoma rufum*
*Robin *Turdus migratorius*
Cedar Waxwing *Bombycilla cedrorum*
*Starling *Sturnus vulgaris*
Yellow-throated Vireo *Vireo flavifrons*
Ovenbird *Seiurus aurocapillus*
*House Sparrow *Passer domesticus*
Bobolink *Dolichonyx oryzivorus*
*Eastern Meadowlark *Sturnella magna*
*Red-winged Blackbird *Agelaius phoeniceus*
*Northern Oriole *Icterus galbula*
*Common Grackle *Quiscalus quiscula*
*Brown-headed Cowbird *Molothrus ater*
Scarlet Tanager *Piranga olivacea*
Cardinal *Richmondena cardinalis*
American Goldfinch *Spinus tristis*
*Rufous-sided Towhee *Pipilo erythrophthalmus*
Vesper Sparrow *Pooecetes gramineus*
*Dark-eyed Junco *Junco hyemalis*
*Song Sparrow *Melospiza melodia*

MAMMALS

Myotis Bat *Myotis sp.*
California Ground Squirrel *Citellus beecheyi*

Table 3 continued.

MAMMALS cont.

*Eastern Chipmunk *Tamias striatus*
Yellow Pine Chipmunk *Eutamias amoenus*
Eastern Fox Squirrel *Sciurus niger*
*Red Squirrel *Tamiasciurus hudsonicus*
Southern Flying Squirrel *Glaucomys volans*
Southern Bog Lemming *Synaptomys cooperi*
Meadow Jumping Mouse *Zapus hudsonicus*
Hispid Cottonrat *Sigmodon hispidus*
Eastern Cottontail *Sylvilagus floridanus*
Brush Rabbit *Sylvilagus bachmani*

REPTILES

Yarrow's Spiny Lizard *Sceloporus jarrovi*
*Western Fence Lizard *Sceloporus occidentalis*
Skink *Eumeces sp.*

1. Not all prey species reported in literature are listed. Sources for food habits data are: Bent (1937), Borsell (1937), Norris (1942), Linduska (1943), (Leopold (1944), Fitch et al. (1946), Hamerstrom and Hamerstrom (1951), Craighead and Craighead (1956), Meng (1959), Nelson (1968), Duncan (1966), Storer (1966), Snyder et al. (1973), and Snyder and Wiley (1976).

*Those species found to be important prey items, making up a significant portion of the diet of Cooper's hawks from different areas.

Table 4. Comparisons of the percentages of birds, mammals, lower vertebrates, and invertebrates in the diet of North American accipiters.

Species	Percent Item in Diet				Area	Source
	Birds	Mammals	Low.Vert.	Invert.		
A. gentilis	53.8	37.0	0	9.1	General[a]	Snyder and Wiley 1976
	90.6	9.4	0	0	Arizona	Snyder and Wiley 1976
	44.8	55.2	0	0	General[a]	Storer 1966
	61.0	39.0	0	0	New York	Meng 1959
	71.7	28.3	0	0	California	Schnell 1958
mean	64.4	33.8	0	1.8		
A. cooperii	66.8	22.2	8.9	2.1	General[a]	Snyder and Wiley 1976
	82.3	17.7	0	0	General[a]	Storer 1966
	55.0	29.0	7.0	9.0	General[a]	Duncan 1966
	82.0	18.0	0	0	New York	Meng 1959
	90.7	9.3	0	0	Michigan	Craigheads 1956
	84.4	15.6	0	0	Wisconsin	Hamerstroms 1951
	56.5	29.6	0	13.9	Arizona	Snyder et al. 1973
	29.3	7.4	63.4	0	California	Fitch et al. 1946
	87.0	12.0	1.0	0	California	Walton et al. 1976
mean	70.4	17.9	8.9	2.8		
A. striatus	93.1	2.0	0.6	4.2	General[a]	Snyder and Wiley 1976
	97.1	0	0	2.9	Arizona	Snyder and Wiley 1976
	97.0	3.0	0	0	General[a]	Storer 1966
mean	95.7	1.7	0.2	2.4		

[a]General refers to those studies in which the investigators analyzed stomach contents of accipiters to determine food habits. Birds analyzed probably were from the northeast United States, presumably on migration. The other researchers employed field techniques, principally the collection of prey items at nests or plucking perches and direct observations of nests from blinds. Some field studies may under estimate percentages of reptiles and insects.

Snyder and Wiley (1976) presented data on differences in the diet between the male and female of both Cooper's hawks and sharp-shinned hawks. For these 2 species the differences in the sizes of prey species taken by the adult males and females were significant. The preferred sizes of prey species for sharp-shinned hawks also varied according to the habitat in which the pairs were nesting. This is obviously related to differences in the relative abundance and availability of certain species of various sizes in the different habitats. Mueller and Berger (1970) showed that both sex and age of migrating sharp-shinned hawks influences their prey preferences, and also that hunger plays an important role in the birds' reaction to prey.

If the species listed in Tables 1,2, and 3 were presented by groups according to sizes (weight categories) it would be apparent that the 3 species of accipiters take significantly different-sized prey. The sharp-shinned hawk takes many species of small sized prey, the Cooper's hawk intermediate sized prey, and the goshawk rather large prey (Storer 1966). These differences in the diet of each sex and each species have been studied in relation to the high degree of sexual size dimorphism exhibited by this group, although much difference of opinion still exists over the significance and evolutionary consequences of this situation (Storer 1976; Snyder and Wiley 1976).

As the female of each species of accipiter is significantly larger than the male, it is quite possible that the female would prey upon the male given the right situation. This would only be probable during winter when pair bonds have been absolved and food is scarcer. Also, goshawks no doubt ocassionally prey on Cooper's hawks and sharp-shinned hawks, and Cooper's hawks upon sharp-shinned hawks. Each of the accipiters may fall prey to other raptors such as the red-tailed hawk *(Buteo jaimaicensus)* and great-horned owl *(Bubo virginianus)*.

Much of the prey of the accipiters is in one way or another under the watchful eye of man. Both goshawks and Cooper's hawks may prey heavily on game species and in some cases specialize on them even when other species are available. The limited data available on the overall effects of accipitrine predation on game species suggests that while the extent of predation in some cases can be substantial, the long term effects are minimal. Eng and Gullion (1962) found that goshawks were probably responsible for more than 50% of the overwinter losses from each age class of ruffed grouse in Cloquet Forest, Minnesota during the period 1957-1960. They felt that goshawk predation was the single most important mortality factor for full grown grouse in this unhunted population, accounting for more than 30% of the losses of banded grouse. However, as the overall productivity of grouse on their area was comparable to other (perhaps hunted) areas, they concluded that the goshawk predation did not have a serious effect on the overall grouse population.

Craighead and Craighead (1956) reported that an inactive Cooper's hawk (one tethered to a falconer's perch) required about 20% of its body weight in food each day during spring and summer. Requirements of a wild hawk might be 1 to 2 percent greater than this. Goshawks require about 120-150 gm/day, or about 10-15% of their body weight (Brown and Amadon 1968). No figures are available for the requirements of sharp-shinned hawks, but considering their small size and high temperament, food needs could reach 23-25% of their weight per day.

The amount of food required by young hawks in the nest has been estimated for goshawks (Schnell 1958), and for Cooper's hawks (Fitch et al. 1946; Meng 1959). Schnell estimated that from birth to time of fledging 2 nestling goshawks would require about 13 kgm of food. Depending on the size of prey taken the adults would thus have to capture between 100-250 prey items during the season. Fitch et al. (1946) report that a young Cooper's hawk requires 62.3 gm of food per day, or about 2,741 gm during its first 6 weeks of life. This amount is only about one-third to one-half of the food required by a young goshawk. Meng (1959) reported that Cooper's hawks that feed on birds and mammals need to capture 266 prey items to feed a brood of 4 young for the first 6 weeks. Meng states that at a typical nest, 4 items per day are brought in the first week, 5 items/day the second week, 7 items/day the third week, 9 items/day the fourth week, 7 items/day the fifth week, and 6 items/day the sixth week. Meng thus estimated that it takes about 60-70 prey items, consisting of small and medium birds and mammals, to raise a Cooper's hawk to the age of 6 weeks.

Movements

Each of the accipiters is migratory to a greater or lesser degree, and even in the resident populations the birds will leave the nesting area and exhibit localized wanderings. There are few records of accipiters remaining in the vicinity of their nesting site the year 'round, which does occur in some of the larger hawks, eagles and falcons. Information on the movements of accipiters has come largely from the hawk banding stations in the eastern United States and Canada. Data are fairly complete on the migrations of the northern segments of goshawk and sharp-shinned hawk populations, as they tend to funnel through the eastern hawk flyways.

Cooper's hawks are much less common in the North and are thus less likely to be seen in large numbers on migration. Information suggests that the Cooper's hawk is partially migratory, a few birds wintering throughout the breeding grounds, with the majority of the northern birds moving southward varying distances. Cooper's hawks in the southern portions of the range are often resident, but leave the snow-covered forests and canyons for the desert valleys, low woodlands and coastal plains (Bent 1937; Brown and Amadon 1968; Beebe 1974).

Cooper's hawks leave their northerly breeding grounds around late August or early September. At counting stations their numbers peak during the second and third weeks of September and then in the spring during the third and fourth weeks of March (Haugh 1972). Their absence from the breeding grounds is about 6 to 7 months.

The sharp-shinned hawk is one of the more migratory species of North American raptors. The extent of migration in sharp-shinned hawks differs between the races. *A.s. velox* appears to make a complete exodus of its northern breeding grounds and travel great distances southward. The Northwest coast sharp-shinned hawk, *A. s. perobscurus*, will leave its breeding grounds

but remain along the north Pacific coast. *A.s. suttoni* is the least migratory, restricting its movements to altitudinal migrations out of the mountains and into the desert lowlands. Along the eastern flyway the majority of sharp-shinned hawks *(A.s. velox)* are seen between 10 September and 20 October. During this time 2 peaks are evident, one in mid-September consisting mostly of immature birds and one in mid-October consisting mostly of adults (Mueller and Berger 1967 a; Haugh 1972). During spring migration the peak number of birds at Hawk Mountain is seen in the third week in April. Sharp-shinned hawks are thus absent from their breeding grounds for as much as 7 to 8 months, depending on the latitude.

The movements of goshawks are similiar to those of sharp-shinned hawks in that each race will exhibit characteristic migration patterns.

Banding studies have shown that few individual sharp-shinned hawks follow the same path on migration in 2 consecutive years. The most southerly recovery has been of a bird recovered in south-eastern Guatemala 1 or more years subsequent to the time of banding (Mueller and Berger 1967 b). During migration sharp-shinned hawks may move up to 70 miles per day (Cochran, in Anonymous 1971). In the northern part of their range they either move southward to southerly latitudes or westward to lower elevations. A portion of the northern population overwinters when conditions are favorable. Goshawks are absent from their breeding areas for 5 to 6 months. In fall they are the last of the accipiters to show up at counting stations, peaking during the second week of November, and in spring they are the first to return, in early March. This short non-breeding period is the result of the rather long breeding season and post-fledging period in goshawks, as compared to the smaller accipiters.

An analysis of goshawk migration, the fluctuations in numbers seen, ratios of age and sex classes migrating and factors on the breeding grounds which affect the migration are presented in Mueller and Berger (1967 b, 1968) and Mueller et al. (1977). Over the period 1950-1974 the number of goshawks recorded at Cedar Grove Ornithological Station in Wisconsin varied from none to 206, with relatively few birds recorded generally and "invasions" of large numbers of goshawks occurring at 10 year intervals. In non-invasion years, juveniles predominated, but during invasion years the proportion of adults exceeded 50%. These invasions of large numbers of goshawks are related to the cyclic fluctuations of their prey, snowshoe hares and ruffed grouse, on the breeding grounds. During low prey years the productivity of goshawks is reduced and few of the adults can over-winter on the breeding grounds. Female goshawks will normally displace the smaller males during fall when food becomes scarce and the males will appear most frequently on migration. In low prey years, both sexes will migrate extensively, and the ratio of the migrating sexes will be nearly equal.

Goshawks in Alaska have been shown to undergo similiar population fluctuations (McGowan 1975). There is little information on whether the goshawks in the Southwest also fluctuate in this apparent 10-year cycle. It is suspected to occur, but with less severity as the diversity of potential prey would be greater in the Southwest and thus allow the hawks to take advantage of other species when one is depressed. The goshawk appears to be the only North American falconiformid that is cyclical in this manner. Goshawks in Finland show similiar population trends and movement patterns (Sulkava 1964).

The only information on the movements of accipiters in a resident population comes from McGowan's (1975) study of goshawks in interior Alaska. He showed that juveniles are more mobile than adults (consistent with the observations on migrating birds stated previously and that males, particularly juveniles, are more mobile than females. Movements averaged 3.4 km for adults, 21.3 km for juvenile males and 19.8 km for juvenile females. McGowan felt that the movement of birds was greatest in early fall and decreased somewhat with the onset of winter.

Nesting Chronology

Raptors must time their breeding activities such that the supply of prey items will be greatest when the demands for food are the greatest, i.e. during the development and training of the young. The high dependence of accipiters on nestling birds and young mammals suggests that ideally, the breeding season is timed so that the young of the prey species will be emerging at about the same time as the young accipiters. The breeding season of accipiters falls within fairly narrow limits although variation does exist between regions, between species, and between individual pairs.

Goshawks arrive at their nesting area in late March and early April; Cooper's hawks in the last week of March through mid-April; and sharp-shinned hawks during the first 2 weeks in May. Pair formation, nest construction, and the initiation of copulation take from 2 to 4 weeks and egg-laying will then follow. One egg is laid each day until the clutch is complete, and incubation probably begins with the laying of the next to the last egg. Reynolds (1978) found that during egg-laying sometimes one or more consecutive days may be skipped prior to the completion of the clutch.

Figure 5 illustrates the timing of egg-laying for the accipiters for 3 different regions in North America. Dates presented in McGowan (1975) for goshawks in Alaska and Reynolds (1978) for accipiters in Oregon corroborate the data in Figure 5. McGowan and Reynolds report almost the same mean clutch completion date (May 5 and May 6) for goshawks in Alaska and Oregon, respectively. In Oregon, goshawks showed the greatest variability in clutch completion dates of all the accipiters. Clutch completion dates for goshawks varied from 9 April to 3 June, for Cooper's hawks from 29 April to 31 May and for sharp-shinned hawks from 11 May

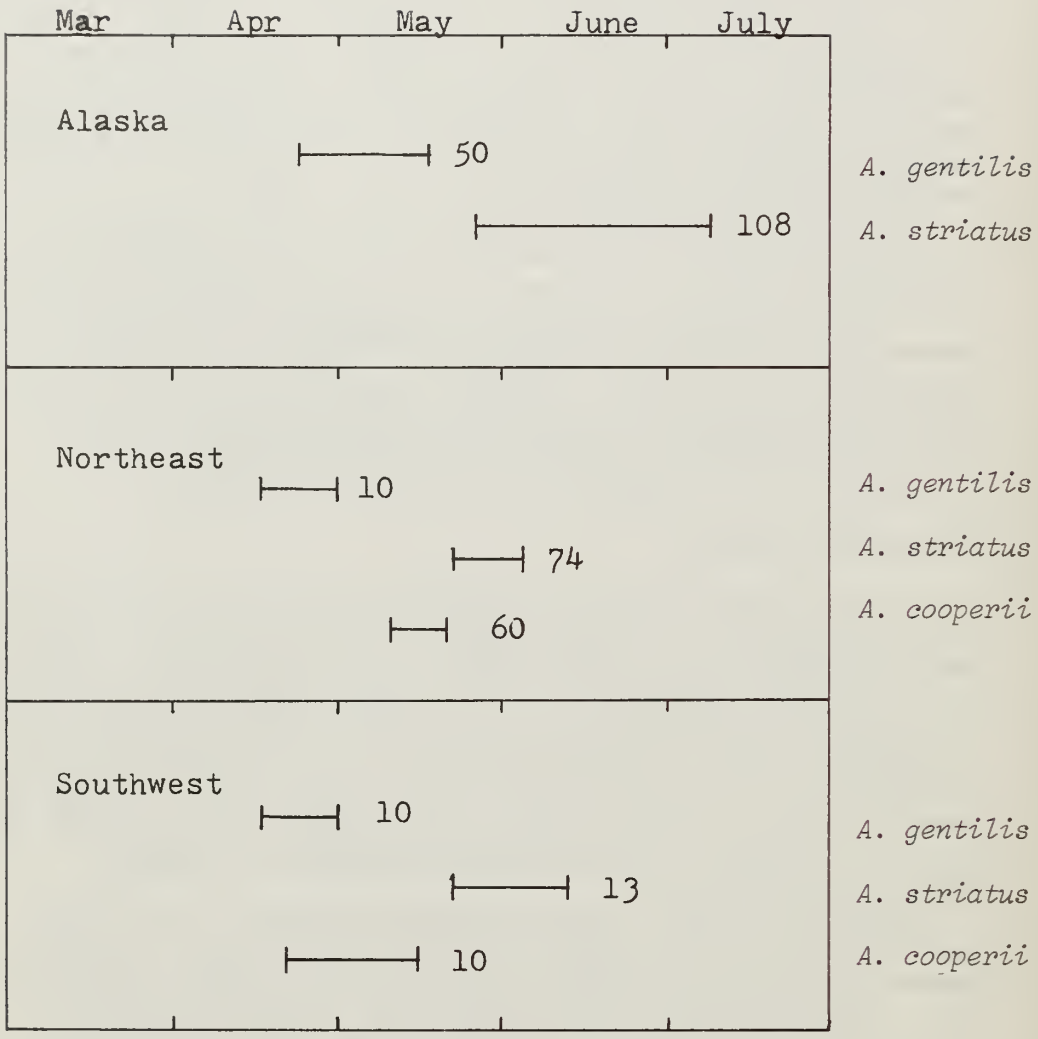


Figure 5. Timing of egg-laying by North American accipiters. Bars represent the median 50% egg dates as given by Bent (1937). Numbers of egg dates represented are given after each bar. Figure from Snyder and Wiley (1976).

to 19 June. Platt (1973) reported a south to north progression in the time of egg-laying in sharp-shinned hawks in Utah. In southern Utah eggs are laid during the second week in May, in central Utah during the fourth week in May, and in northern Utah during the first week in June. Such a progression has not been verified elsewhere. Reynolds (1978) reports that a linear regression of initiation of incubation and the elevation of 30 goshawk nests in Oregon suggests little if any association between the timing of breeding and elevation ($r = .075$). Within a given year, however, severe and fluctuating weather conditions should produce a pattern of gradual onset of breeding with increasing latitude or elevation.

Reported incubation periods vary considerably with authors. The most accurate estimates seem to be 30-32 days for each species (Platt 1973; Reynolds 1978; and McGowan 1975). Eggs hatch over a period of 1 to 3 days, and hatching occurs approximately 12-18 hours after start of pipping. The period of time that young remain in the nest can vary with the sex of the bird, as males develop faster, and also with individual temperaments. In Oregon the nestling period was calculated at 34-37 days for goshawks, 27-30 days for Cooper's hawks and 21-24 days for sharp-shinned hawks (Reynolds 1978). Goshawks in Alaska apparently take somewhat longer to fledge, between 37-41 days (McGowan 1975). The observed variation is mostly a result of the more rapid fledging by the male. Fledging of young accipiters takes place between mid-June and the first week in August, with the majority of young leaving their nests during the last week in June up to mid-July (Bent 1937; Fitch et al. 1946; Craighead and Craighead 1956; Schnell 1958; Brown and Amadon 1968; Platt 1973; McGowan 1975; Reynolds 1978).

Information on the length of the post-fledging period when the young are learning to hunt and still dependent on the adults is scarce because of the difficulty in observing the young and the probability that they might leave the immediate nesting area. Reynolds (1978) suggests that fledgling dependency may persist for as long as 42 days for goshawks and 53 for Cooper's hawks in Oregon. Platt (1973) found that groups of fledgling sharp-shinned hawks remained together for at least 3 weeks, and are not known to have left the nesting area during this time. During nest building the pair will roost together near the nest.

The male hunts and provides all food for the female during this time, and throughout the incubation and brooding periods. When the male has prey for the female, he flies to the edge of the nesting area and utters a special call which is never given by the female. Schnell (1958) describes the note as "an unmusical sound, having somewhat the tone produced by a person snapping the tongue away from the roof of the mouth." When the female hears this call note she flies out to get the food. The transfer of prey may be made in the air, with the male dropping the prey for the female to catch, or while the male is perched and the female just takes the prey from him.

Once egg-laying is complete and incubation begun, the behavior of the male and female becomes quite regular and consistent. The male hunts during the early morning hours and late afternoon, and when not hunting should be perched somewhere within the nesting grove. Both birds share in the incubation, though the male may only incubate when the female is feeding or in need of exercise. The adults are quiet during this time except when the male delivers food. The female spends the night on the nest, and the male perches nearby. During incubation the female's hunting is limited to fortuitous sightings of prey exceedingly close to the nest.

As hatching approaches the adults become much more excitable and it is this time that they are the most aggressively protective of the nest site. Their heightened aggression continues during the brooding period and only decreases as the young near fledging. The aggression displayed by nesting goshawks has been noted by all observers of nests, and this species is regarded as probably the most fearful of any North american raptor. The defensive call of goshawks is a loud "kak, kak, kak" repeated many times at a fast rate. All intruders into the nesting area are subjected to a vocal accosting and physical attack. The female is generally more aggressive than the male.

After the young hatch the daily behavior of the adults changes markedly. The male continues to provide food for the female and young, but will spend less and less time in the nesting area. During the first week or so after hatching, the male may roost in the nesting area, but will eventually spend all his time away. When the female receives food from the male during this time she will utter a "dismissal call" and the male leaves. The female may chase the male out of the nesting area, and may not begin to feed the young until the male has left. When the young are small some food is cached for later consumption. The female will also cache food if she is disturbed while feeding the young. Food items are cached at varying distances from the nest and usually eaten later the same day or the next morning. The female broods the young almost continually for the first 7 to 10 days and then less as they develop. However, the female will always be near the nest, even during hunting, and will roost within 100 meters of the nest. The female does not begin hunting until the young are in need of greater amounts of food and the male cannot provide enough. The young are fed by the female, sometimes even after they are old enough to tear the prey apart themselves. During brooding and raising the young, the female and sometimes the male will bring live sprigs or small sticks to the nest and work them into the structure.

As the young approach fledging, they become increasingly aggressive towards the female at feeding time. The female will often just fly in and drop food at the nest, without attempting to feed the young. Live prey may be brought to the young as they get older. The fledging process involves first, short hopping flights to outer branches of the nest tree, and then short flights to other trees.

Breeding Behavior and Daily Cycles

When goshawks arrive at their breeding grounds, the female initiates courtship and will select a nesting area and scream to attract a mate. Courtship activities are the same whether the pair has mated in the past or for the first time. Flight display involves the pair soaring and flying over the nesting area with rather slow and measured wingbeats. During flights the under-tail coverts are spread and become quite conspicuous. The male may initiate such flights by performing an undulating display or diving at the female from a soaring flight, or by chasing the female in direct flight through the forest (Holstein 1942; Brown and Amadon 1968; Beebe 1974).

It is unclear which bird selects the nest. Holstein (1942) felt that the female chose and helped build the nest if an old nest was to be used and the male chose and built the nest alone if a new nest was to be built. During nest construction the hawks daily cycle consists of a combination of courtship activities, nest building, copulation, and hunting. Each morning the pair performs a "shrieking duet" upon waking. First the male and then the female will utter a series of clucking sounds, which are evenly spaced and repeated for about 5 to 10 minutes. The calls during flight displays are loud "kree-ya, kree-ya", much like the begging calls of the young. Nest building takes place in the morning and ceases by about 12:00 noon. Courtship feeding of the female by the male begins during nest building. Copulations are frequent, perhaps as often as 10 times a day, and continuing throughout the egg laying period. The display of the under tail coverts by the male may play an important role in soliciting the female before copulation. Once flying, the young follow the adults about during the day and continually harass them for food. The young return to the areas around the nest to roost, and may actually roost on the nest itself.

The breeding behavior of Cooper's hawks is very similar to that of goshawks, with only a few significant differences. In Cooper's hawks the male is the first to initiate courtship, and upon arrival at the breeding area, the male will defend a small area about 100 meters in diameter and attempt to attract a mate by calling. He will feed a receptive female and attempt courtship. One or both birds may engage in courtship flight, which is usually most common in early morning. The birds fly over the nesting grove or over an open field with their wings lifted high above their backs and moved through a deep arc. The male selects and builds the nest, sometimes aided by the female. During nest building and incubation the daily patterns of behavior in Cooper's hawks are like those of goshawks. The early morning chorus of the pair sounds very similiar to that of goshawks. Cooper's hawks are generally less aggressive than goshawks, but still can be dangerous and are less intimidating only because of their smaller size.

Little is known of the breeding behavior of sharp-shinned hawks. Courtship activities should be similar to those of Cooper's hawks and goshawks. Newton and Blewitt (1973) provide an excellent description of the courtship in *A. nisus* which should reflect behavior in sharp-shinned hawks. They state "A single hawk or a pair may fly to and fro over the nesting area on slow deliberate wingbeats, dipping up and down; the undulations are more marked at greater heights. Then the hen may spiral up, again on slow wingbeats, to about 60 meters, make 3 or 4 normal flaps to get up speed, rise abruptly for 6-10 meters, then plunge into a long dive with wings closed. This performance may be repeated several times before settling. While a hen displays thus, her mate may sometimes be heard calling from the trees below. When both sexes are in the air, the cock is usually uppermost. Aerial displays occur mainly on sunny mornings, and more than 2 hens may perform at once; as well as functioning in courtship, they probably serve to advertise the nesting area to other sparrowhawks, thus helping spacing."

In sharp-shinned hawks, as in the other accipiters, the male vacates the nesting area soon after the young hatch, and only returns to bring food. The male will deliver food to the female and young directly at the nest and will remain for varying periods of time. Platt reported that the female remained within the nesting grove until the young were at least 10 days old, and it was not until they were 15 days old that she began to spend considerable time away from the nest.

Accipiters, as most hawks, become sexually mature before they moult into full adult plumage. Most accipiters begin breeding their second spring, when 2 years old, although a small percentage of birds breed in their first year. Henny and Wight (1972) report that up to 19% of first year Cooper's hawks may attempt to breed, although this consists mostly of juvenile females. Incidents of young males breeding are less common. These same approximate values also hold for goshawks and sharp-shinned hawks (Snyder and Snyder 1974; McGowan 1975).

Pair Fidelity and Nest Site Tenacity

Goshawks and Cooper's hawks probably mate for as long as both birds are alive and generally return to the same tract of woods for nesting each year. Sharp-shinned hawks, however, appear to mate less commonly with the same bird in consecutive years, although different birds may frequent the same nesting area for many years (Brown and Amadon 1968; Beebe 1974). Assuming a pair of accipiters returns to the same area it may either repeatedly use the same nest, alternate between existing nests, or build a new nest (McGowan 1975). Accipiters exhibit definite preferences for certain areas, much as large falcons do for certain cliffs (Hickey 1969), and as a result traditional nesting areas may have from 1 to 5 old nests in them. The nesting site is considered to be that area containing the nest(s) and structural and physiographic features utilized by the nesting pair (Reynolds 1978).

McGowan (1975) found in Alaska that at 21 sites where stick nests were observed from the air, intensive ground searches revealed that only 4 of the 21 sites contained a single nest. McGowan considered such locations with 2 or more nests clumped within an area of 0.8 km in diameter to be traditional goshawk nesting sites. One site was used for 4 consecutive years, but no site was active all 5 years. A total of 13 sites was active at least 2 consecutive years. Use of traditional sites was dramatic, from 83-100%, and the non-traditional sites were usually occupied by yearling females.

Reynolds (1978) concluded that the nest site tenacity increased with accipiter size; sharp-shinned hawks occupied sites for a maximum of 2 years, Cooper's hawks for 3 years, and goshawks for 5 years. In Oregon 2 nest sites of 1 species were later reoccupied by another species. In 1 case a site used for 2 seasons by a pair of sharp-shinned hawks was occupied by a pair of Cooper's hawks the next year. The second instance involved Cooper's hawks reoccupying a site used previously by goshawks.

Brown and Amadon (1968) report that Cooper's hawks may use the same nest for 4 consecutive years. Platt (1973) reports that for sharp-shinned hawks in Utah there is 1 record of reoccupancy of an old nest and that traditional groves (same as "site" above) are commonly used and may contain as many as 5 old nests. If a pair nests at the same site but does not utilize an old nest, the new nest is usually within close range, from 50-100 meters, of the old nest.

Nesting Densities and Home Ranges

Information on nesting densities of the accipiters is scarce and limited to the West. For goshawks, there are comparative figures for Alaska, Oregon and Colorado. In Alaska McGowan (1975) found breeding densities of 1 pair per 46-55 km sq. from 1971 through 1973 (average of 8 active nests) and then densities of 1 pair per 372 km sq. in 1974 (1 active nest). The closest distance between any 2 nests was 2.4 km in 1971 and 3.1 km in 1972. In Colorado, Shuster (1977) found goshawks nesting at a minimum density of 1 nest per 13.3 km sq (6 nests). Shuster found 2 nests on his study area 2.4 km apart in 1974 and just 0.8 km apart in 1975. In Oregon Reynolds found 4 nests on 11,741 hectares for a density of 1 pair per 2,750 ha. in 1974. The mean distance between nest sites was 4.3 km.

The only data on the nesting densities for Cooper's hawks and sharp-shinned hawks is that of Reynolds (1978) for Oregon. In 1970 4 Cooper's hawks nests were located on 9284 ha. for a density of 1 nest per 2,321 ha. The mean distance between nests was 4.7 km. In 1971 5 nests were found on the same study area for a density of 1 nest per 1,857 ha. and 5 nests on another study area (same as for the goshawks) for a density of 1 nest per 2,200 ha. Mean distances between the nests were 5.4 km and 3.1 km for the 2 study areas, respectively. Reynolds reports that

for sharp-shinned hawks, 4 pairs were nesting on the 11,741 ha. study area for a density of 1 pair per 2,750 ha. The mean distances between these nests was 4.3 km.

The concept of territoriality in accipiters is poorly defined. The nesting territory, the area in which all intruders are evicted or at least challenged, is not necessarily the same area hunted and appears to be a rather small area, about 100-200 meters in diameter, with the nest at its center. Platt (1973) found that sharp-shinned hawks in Utah will regularly fly up to 1,200 meters from their nesting area to their hunting range, and will not utilize the areas in between. Craighead and Craighead (1956) calculated the nesting season ranges for the accipiters in Michigan and Wyoming. They defined the nesting range as the "area over which a pair of hawks moves in performing the activities associated with the nesting cycle. The living requirements of a nesting pair are met within this area." Referring to the studies above, the nesting ranges would be the nesting territory and the hunting range included. The Craigheads report that for 2 pairs of Cooper's hawks in Michigan the nesting ranges were 1.43 and 1.55 sq miles in 1942 and for another 2 pairs, 0.37 and 1.45 sq. miles in 1948. For sharp-shinned hawks in Wyoming they reported a range of 0.26-0.51 sq. miles, and for goshawks in Wyoming a range of 0.82 sq. miles.

Moult

The plumage that young accipiters have when they leave the nest is known as the juvenile plumage, and during the first year they will change little in appearance except that their flight and tail feathers will become badly worn, and some perhaps broken. The white tips of the tail feathers are usually worn off by December. If the hawk breaks a feather, it may pull the feather out and another will grow in if the follicle is not damaged. The new feather will be of the next year's plumage (Brown and Amadon 1968).

The first moult usually begins in April of the following year, and may take from 4 to 6 months to complete. Primaries are moulted from no. 1, the inner-most primary, outward to no. 10, the outer-most primary. Primaries are moulted alternately on both wings. The secondaries are moulted later than the primaries. Tail feathers are moulted from the central 2 "deck" feathers outwards. The moult of the tail feathers is begun after that of the primaries. The time from the dropping of a feather to the complete growth of its replacement will vary with the condition of the bird, but usually is about 4 to 6 weeks. The plumage acquired at the first moult is known as the adult I plumage. It differs from the full adult or adult II plumage in that not all of the back feathers and scapulars will be moulted and the hawk will have a mixture of bluish adult feathers and brownish juvenile feathers on its back (Bent 1937; McGowan 1975; Mueller and Berger 1968).

Adult plumage is acquired during the second moult, beginning when the hawk is about 23 months old. This moult and the consecutive moults are begun slightly later and are of shorter duration than the first moult. In addition to coloration changes associated with each moult, the flight and tail feathers of accipiters are longer in adults (both classes of adults, I and II) than in juveniles. Also, accipiters increase in size from juveniles to adults (Brown and Amadon 1968; Mueller et al. 1976; Mueller et al. 1979).

The moulting sequence in accipiters is correlated with events of the breeding cycle. Females are the first to begin moulting, at about the time they begin incubation. The female will undergo a very rapid moult while incubating and then stop moulting when the young hatch and she resumes hunting activities. The male on the other hand does not begin his moult until the female is off the nest and assisting him in hunting. The female may be as much as halfway through her moult before the male begins his. The female resumes her moult after the young are flying and learning to hunt on their own. The delayed start of the moult of the male is presumably a result of his responsibility as the sole provider during the incubation state, and suggests that moulting can decrease hunting abilities or efficiency (Platt 1973; McGowan 1975).

Productivity and Pesticides

The productivity and breeding habits of birds are related to the longevity of individuals and the mortality experienced under normal environmental conditions.

The mortality that accipiters experience generally decreases with increasing body size and consequently, the productivity is also less. Mean clutch size is 4.3 for sharp-shinned hawks (4.8 for *A. nisus*), 4.2 for Cooper's hawks, and 3.2 for goshawks (Table 5). One egg clutches are occasionally recorded, at least for goshawks and Cooper's hawks (Brown and Amadon 1968; McGowan 1975).

A discussion of hatching percentages, numbers of young fledged, and overall productivity rates must also include a discussion of the current levels of pesticides in the accipiters and their effects on the species' productivity. The relationship between DDT content in eggs and the occurrence of egg breakage has been documented for many taxonomic groups of birds (Ratcliffe 1970), and recently also for the North American accipiters (Snyder et al. 1973). Normally, the percentage of eggs hatching is quite high, between 90 and 100%. Addled eggs are infrequent, but regular. Since the introduction of DDT in 1947 the incidence of egg breakage in raptors has increased significantly, and is one of the factors responsible for the near demise of the peregrine falcon in the eastern United States (Hickey 1969). Ratcliffe (1970) reported that in *A. nisus* egg breakage did not become widespred until after 1947. The data on *A. nisus* from Newton (1974) suggest that it was this increase in frequency of egg breakage after 1947 that led to the drop in production of young and subsequently the population decline observed in *A. nisus* in Britain.

Table 5. Comparative data on the productivity of North American accipiters, the European goshawk and the European sparrowhawk. Adapted from Reynolds (1976).

Species	Clutch Size	Number Hatched	Number Fledged	Percent Hatched	Percent Fledged[a]	Year	Location	Source
A. striatus	3.5(2)[b]	3.5(2)	3.5(2)	100	100/100	1947	Wyoming	Craigheads 1956
	4.3(34)	--	--	--	--	1900-70	Utah	Platt 1973
	4.6(5)	3.2(5)	2.7(11)	70	59/81[d]	1969-74	Oregon	Reynolds 1978
mean[c]	4.3(41)							
A. nisus	4.8(635)	--	4.0(117)	--	83/--	Pre-1947	Britain	Newton 1974
	4.8(39)	--	3.2(29)	--	66/--	1947-55	Britain	Newton 1974
	4.9(46)	--	2.9(219)	--	60/--	1956-70	Britain	Newton 1974
mean	4.8(720)							
A. cooperii	4.18(117)[e]	--	3.53(118)[f]	--	84/--	1929-45	Northeast	Henny and Wight
			3.08(26)	--	74/--	1946-48	U.S.	1972
			2.67(54)	--	63/--	1949-67		
	4.2(36)	--	--	--	--	1948-50	New York	Meng 1951
	4.3(6)	3.0(6)	3.0(6)	70	70/100	1942	Michigan	Craigheads 1956
	3.8(13)	2.8(13)	2.1(24)	74	55/61[g]	1969-74	Oregon	Reynolds 1978
	4.26(124)	--	3.43(198)	--	82/--	1972-75	California	Walton et al. 1976
mean	4.2(296)							
A. gentilis atricapillus	3.2(33)	--	2.0(33)	90	98/--	1971-73	Alaska	McGowan 1975
	3.2(5)	2.6(5)	1.7(48)	81	53/72[h]	1969-74	Oregon	Reynolds 1978
mean	3.2(38)							
A. gentilis gentilis	3.4(22)	--	1.5(28)	--	44/--	1955-58	Finland	Hakila 1969
	2.8(9)	--	1.8(9)	--	64/--	1937-40	Denmark	Holstein 1942
mean	3.2(31)							

[a]Percent fledged from clutch size/Percent fledged from number hatched.
[b]Sample size, number of nests.
[c]Mean calculated for clutch size only, as number hatched and fledged has changed with time periods.
[d,g,h]Values from Reynolds; different sample size used.
[e]Overall clutch size for 1880-1967.
[f]Data from successful nests only. Unsuccessful nests and nests in which eggs hatched but were all lost are not included.

Similarly, the drop in productivity in Cooper's hawks in the northeastern United States after 1945 (Table 5, Henny and Wight 1972) is believed to have resulted from high incidences of egg breakage. Henny and Wight calculated that with the observed drop in productivity after 1945 (averaging 1 less young fledged per successful nest) the population would be declining at a very fast rate. They add that this declining reproductive rate is of much greater consequence than the effects of shooting (estimated to claim between one-fourth and one-half of the young in the Northeast each year prior to 1941) because it acts as a biological control, with birds still competing for resources, but contributing less to the population.

Reynolds (1978) found that nestling mortality in Cooper's hawks was high and greater than in sharp-shinned hawks or goshawks. Only 61.4% of the nestling Cooper's hawks lived to fledging age, compared to 72% for goshawks and 81% for sharp-shinned hawks. This high mortality in Cooper's hawks was attributed to the species' preference of nesting in rather open country, compared to goshawks or sharp-shinned hawks, which would allow predation by other raptors or owls. Data from Henny and Wight (1972) on fledging success of Cooper's hawks (84%) are not comparable to those of Reynolds as only successful nests were utilized in the calculations.

Considering the above information, accipiters should normally fledge about 1 less young than the number of eggs laid, and consistent and long term deviations from this should be cause for concern. Referring to Table 5 the only recent estimates for productivity consistent with pre-DDT estimates are those of Walton et al. (1976) for Cooper's hawks in California and McGowan (1975) for goshawks in Alaska. Reynolds (1978) reports that of the accipiters in Oregon, both sharp-shinned and Cooper's hawks showed signs of reduced hatching success because of pesticides. Hatching success for sharp-shinned hawks in Oregon was 69.6% and for Cooper's 74.0%, compared to 81.2% for goshawks. Snyder et al. (1973) presented data on the current levels of DDE in the eggs of accipiters. Three goshawk eggs ranged from 0.28 - 0.41 ug/ml (mean 0.36), 4 Cooper's hawks eggs ranged from 0.80 - 3.18 ug/ml (mean 1.73), and 3 sharp-shinned hawk eggs ranged from 20.3 - 119 ug/ml (mean 62.32). Levels of DDE above 3-4 ug/ml in eggs were found to represent significant levels of contaminants, associated with frequent egg breakage and possibly disturbed behavior. Snyder et al. reported similar levels in the eggs of the accipiters in Arizona and New Mexico and for Cooper's hawks in Pennsylvania and New York. A significant relationship was found between the percent birds in the diet of Arizona-New Mexico Cooper's hawks and the levels of DDE in the eggs of these pairs. They concluded that both the sharp-shinned hawk and Cooper's hawk showed signs of DDE stress but the goshawk did not. The levels of DDE in Cooper's hawks from the East are several times greater than the levels in the West. They mentioned that the high levels of DDE in sharp-shinned hawks in the West suggest exceedingly high levels in the East. No cases of egg breakage in the goshawks have been recorded.

Longevity and Mortality

Accurate information on the longevity and mortality of raptors comes mostly from banding studies, and limited information from animal parks and zoos. Most raptors show an extremely high mortality rate the first year and then lesser rates thereafter. Regarding the accipiters, shooting has always been an important mortality factor and recently, poisoning by organochlorine pesticides, (causing reduced productivity) has also been important. It appears that for the accipiters the single most important mortality factor is starvation associated with difficulty or inexperience in gathering food or changes in local prey species abundance and diversity (Snyder and Wiley 1976). Other mortality factors may include the predation of eggs or young by mammalian predators (Craighead and Craighead 1956), the predation of young or adults by other raptors (Reynolds 1978) and accidental deaths by electrocution, drowning, or collision. A fair number of accipiters are found dead each year after they have crashed into windows or doors of buildings.

Brown and Amadon (1968) presented information on the longevity of various species of raptors. For Cooper's hawks the number of birds recorded by specific ages is as follows: 1 year (100), 2(14), 3(3), 4(4), 5(5), 6(0), 7(1), 8(2); total records, 129. For goshawks the records are: 1 year (10), 2(1), 3(1), 4(1), 5(0), 6(0), 7(2); total records 15. No data are presented for sharp-shinned hawks, but the following records for the European sparrowhawk may reflect logevity pattterns in the sharp-shinned hawk: 1 year (38), 2(39), 3(12), 4(5), 6(5), 7(0), 8(0), 9(1); total records, 100. When the records for Cooper's hawks are expressed as a ratio of the birds dying each year to the birds alive at the beginning of the year (percentage) it is found that after an initially high mortality of 75% the first year, the remaining population decreased by an average of 41% each year thereafter.

Henny and Wight (1972) calculated life tables and mortality rates for Cooper's hawks for the periods 1925-1940 and 1941-1957. The division was made because of more shootings during the earlier period. For the period 1925-1940 it is estimated that first year mortality was 82.5% and 44.0% $\pm$ 6.6 for the second through the eighth year. They add that these rates are overestimated because of the high percentage of recoveries resulting from shooting. For the period of 1941-1957 mortality rates of 77.8% for the first year, 34.0% $\pm$ 4.0 for the second through the eighth year were calculated.

Comparative mortality rates for goshawks and sharp-shinned hawks are not available. Considering sizes and other factors, the mortality of the goshawk should be similiar but slightly less and that of the sharp-shinned hawk should be slightly more than the rates for the Cooper's hawk.

HABITAT REQUIREMENTS AND NEST SITE SELECTION

The habitat requirements of each of the species of *Accipiter* are fairly specific and regular. The habitat that accipiters are found in will vary with elevation and latitude but within each habitat occupied, the species will select specific ecological situations for nesting. Specifically, accipiters are usually found in mature stands of mixed or pure forests, and the area in which they nest is usually the most dense of the stand. Accipiter nests are usually near a clearing, perhaps 50 to 100 m from the edge of the forest. Most often there is a permanent or temporary stream or lake nearby, and some natural flight path such as a creek bed, a gravel road or break in the vegetation. In riparian situations accipiters prefer canyons, but in certain areas are also common on flood plains. Thus, regardless of the area, accipiters consistently frequent sites with specific geographic and physiographic features. The 3 species overlap in their requirements. In several regions in the United States all 3 species can be found nesting in close proximity to each other (Bent 1939; Schnell 1958; Jones pers. obs.).

Goshawks are considered higher elevation or latitude birds, preferring coniferous or mixed forests and in some areas deciduous forests in the Canadian Life Zone or above (Bent 1937; Dixon 1938; Beebe 1974).

In the Northeast goshawks nest in dense stands of coniferous or mixed forests. Bent (1937) reported that of 62 nesting records he consulted, 11 nests were in conifers (white pine, firs, spruces, hemlock) and 51 were in deciduous trees (birches, beeches, poplars, maples, oak, cottonwood). In the Rocky and Sierra Mountains goshawks frequently nest in mature dense stands of lodgepole pine or quaking aspen in canyons or meadows (Schnell 1958; Schuster 1976; Jones pers. obs.). In mountainous situations goshawks nest on rather flat areas, but the nest is usually close to a steep incline, either a canyon wall or the rise of a range. In Oregon the hawks have been found nesting in dense mature stands of pine or fir on the east and west slope of the Cascade Range, and in the smaller ranges of eastern Oregon. The elevation of the nests here ranges from 580 to 1860 m (Reynolds 1978). In Alaska goshawks nest predominantly in paper birch forests and less so in aspen forests (McGowan 1975). Of the 45 nests McGowan examined 76% were in birch trees, 20% were in aspens, and 4% in balsam-poplar. All but 8 of the nests were situated on hillsides; 64% occupied slopes of southerly exposures, and 36% were on north facing slopes. McGowan concluded birch woodlands are the preferred nesting habitats and that use of aspen groves may be limited to females that nest there as yearlings and then return to aspens each year because of typical site tenacity.

Goshawks build their nests in the middle or upper portions of trees between 20 and 100 ft. high. The height of the nest above the ground will vary from 15 ft. to 75 ft., but averages about 30-40 feet. The nest is most often built in a fork of the tree but occasionally out on a branch. Nests are lined with green coniferous or deciduous twigs, needles, or bark. The lining is replaced periodically throughout the season. If an old nest is used, new sticks are added and it is re-lined. When the eggs are laid there is a definite cup-shaped depression in the nest, but this is evened out as the young grow and more sticks are added to the nest. Nest size averages 14"-36" in diameter and 12"-20" deep (Bent 1937· Dixon 1938; Ingles 1945; Schnell 1958).

Sharp-shinned hawk habitat requirements appear less specific but overlap heavily with those of goshawks. Sharp-shinned hawks can be found in every life zone, and all elevations up to 9,000' or tree line. Most important is a dense stand of trees or a remote hillside in close proximity to a vegetated opening frequented by small birds. In canyons and valleys sharp-shins will nest about 50-100 m up the slope from the floor of the valley and where the forest is fairly dense and trees evely spaced. At lower elevations they appear restricted to coniferous forests though at higher elevations they frequent deciduous trees. The nest site is always hidden in the foliage, and never as conspicuous as the nests of goshawks or Cooper's hawks (Bent 1937; Beebe 1974; Platt 1973; Jones pers. obs.).

The most complete information on nest site selection in sharp-shinned hawks comes from Platt (1976). Of 27 nests examined in Utah, 85% were in conifers, but 65% of the conifers used were in small groves in the midst of a deciduous stand, not in predominant coniferous stands. Of the nests in deciduous trees, only 1 was situated in a tree of the predominant species around the nest site. No nests were in lone trees or even in open stands. Two deciduous trees used were diseased and produced abnormally dense growth. The most common nest site consisted of grouped or scattered conifers in a stand of taller deciduous trees.

Trees used by sharp-shinned hawks range from 20-100 ft. high. The nest is placed in the most dense part of the tree canopy and is constructed next to the trunk. Height of the nest above the ground varies from 6-60 ft. Approximate dimensions of the nests are 24" in diameter and 8" deep. Dry pieces of bark are usually used to line the nest (Bent 1937; Rust 1940; Platt 1973, 1976).

Cooper's hawks frequent a wider variety of habitats than either sharp-shinned hawks or goshawks and are generally considered lower elevation birds. The association of Cooper's hawks and canyons with riparian habitats is marked. In the East it shows preference for both coniferous forests and deciduous woodlands. Of 47 nest records in Bent (1937) 27 were in white-pine woods; 16 in deciduous woods, mostly oaks and chestnuts; 4 in mixed woods, oaks, chestnuts, and pine; and 1 in a pine on an open knoll among

a few scattered oaks. In the plains states Cooper's hawks are most often found nesting in sycamores, cottonwoods, or willows along a stream course or river. In the Southwest and West, chaparral is the preferred habitat, the nest usually located in a small grove of trees in a small canyon. In California Cooper's hawks are fairly abundant in the oak-pine belt stretching along the western side of the Sierras and along the dry southern coast (Bent 1937; Fitch et al. 1946; Walton et al. 1976). The nest tree can be anywhere from 20-120 ft. high. The nest is usually built next to the trunk but almost as often out on a forked branch. It is usually in the upper portion of the canopy. The height of the nest above the ground averages 25-40 feet with rare nests only 10 feet above the ground. Approximate dimensions of the nest would be 28" diameter and 8-10" deep. If a nest is reused, it will be considerably larger. Dry leaves, needles, and most importantly, a bed of bark strips line the inner cavity (Bent 1937; Fitch et al. 1946).

STRATEGIES IN LOCATING ACCIPITER NESTS

There are certain generalizations that can be made about locating nests of accipiters that may be useful to beginning students, forestry personnel, and game biologists. These suggestions will not guarantee ability in finding nests, but they may provide a starting point from which the experience needed to be competent at finding nests is gained.

Nesting requirements of accipiters and the ecological situations in which they will nest will be different throughout the country and in some cases within an area. The most important objective is to become familiar with the nesting situations in a given area and then look for other areas where this specific habitat is duplicated. It is futile to blindly stumble about the countryside hoping that you will run into an accipiter nest. Most often other people, falconers or local ranchers, can be a valuable resource from which nesting areas or even specific nesting sites can be learned. The first step in locating nesting sites is to utilize such people.

In areas where accipiters utilize deciduous trees for nesting, locating nests is easiest during the winter time when the trees are leafless. One simply searches groves of trees or stream banks for appropriately sized stick nests. Once found, such nests should be checked to see if they are lined with bark which is a good indication of recent useage. The general condition of the nest will indicate approximately how long ago the nest may have been used. An accipiter nest will maintain a bowl like structure for up to 3 years. If an area is an active site there will undoubtedly be several nests within several hundred meters of the active nest. If nests are located during the late summer or fall months, the presence of dried mutes, moulted feathers, down, or prey remains will indicate usage of the nest that year. Any such nest thus located should be rechecked the following spring to determine occupancy.

During spring months the best time to search for accipiter nests is early in the morning when the birds would be engaged in courtship activities. Suitable areas should be viewed from a distance and the sky searched for hawks. During their flights, they will often fly over the nest itself and sometimes land on the nest tree. If searching in mid-day, the best strategy is to search the forest or riparian area closely and watch for kill remains, consisting of scattered feathers or body parts, or moulted feathers. This usually indicates that a nest is close by. When searching the forest it is best to watch for clues on the ground rather than for nests in the tree tops. The other strategy is to make oneself as conspicuous as possible and rely on the birds' vocal defense to give away the location of the nest. All species are very defensive of the nesting area as has already been mentioned. If a cackling adult is heard, it is best to then walk concentric circles outward from that point to see where the demonstration by the adults is the greatest. The aggressiveness of the adults will normally decrease the further one is away from the nest site.

The forest types and geographic situations accipiters will be found nesting in will differ across the country and thus generalizations in this area would be hard to make. However, there do seem to be certain characteristics of accipiter nesting areas that make the task a bit more manageable. The habitat requirements of each species have already been discussed. Accipiters will normally select mature forests and stream habitats for nesting. In forests, the structure of the trees in the nesting area is usually very vertical, with the tops of the trees forming a continuous canopy. There are many exceptions to this, but these areas are valuable starting locations for searching. In riparian situations, suitable areas would consist of close, evenly spaced trees where there is more than 1 single row of trees lining the stream.

Accipiters will most often nest on rather flat areas, even in mountainous and hilly country. Flat ravines, valleys or the most gentle slopes available should be checked first. The one exception to this is the sharp-shinned hawk which will often chose to nest up on a slope off the valley floor. In these cases the birds usually nest within 100 meters of the flat area. The nesting tree may be fairly close to a clearing or small open area, and nests are often placed near dirt roads, trails, or creek beds. In some areas nests are found close to running water.

Learning which areas to begin searching is a matter of experience. Remote wooded areas, offering abundant prey species and diverse vegetation and topography are the best first choices. Within any area it is always important to check local check lists to see if the species of interest has been recorded as a breeding species. Audubon society members can be of value in this.

RECOMMENDED SPECIES AND HABITAT MANAGEMENT TECHNIQUES

1. For ultimate protection of the accipitrine hawks it is recommended that development-related habitat alteration, i.e., urban and industrial development, on public lands be prohibited and that the introduction of biologically harmful chemicals onto public lands be discontinued. Although public lands are administered under the multiple-use philosophy, the day is rapidly approaching when public lands will be the last stronghold for our wildlife heritage, and the protection of this heritage should take precedence above all else.
2. For accipiters the single most imminent threat is that of habitat alteration and/or destruction (White 1974). Accipiters need natural stands of forest trees or riparian habitats for nesting and woodlands or forests with stable prey base for hunting. It is important that lands under public jurisdiction be subjected only to conservative human use, such as hiking, boating, or fishing, and that principle habitat features remain stable. Riparian habitats are especially critical to all 3 accipiters for nesting and hunting. In areas destined to undergo development, riparian habitats and adjacent lands up to 400 m on either side should be left undisturbed. Nesting territories of accipiters should be identified and protected by not allowing disturbances within 400-500 m of the nest site.
3. The population decline of the Cooper's hawk in the East and the possibility of a decline in the West should be widely publicized in order that the species receive appropriate legislative status to allow for its protection in those areas where it is threatened.
4. A reduction in indiscriminate shooting of accipiters can be achieved only by public education and the enforcement of strict laws prohibiting such actions. The creation of alternatives other than shooting for the farmer or rancher subjected to accipitrine marauding is recommended. One such alternative would be for the hawks to be trapped and transported to another area. State Fish and Game departments should be able to find volunteer falconers willing to help out in such ventures. This technique is known to have been successful in reducing predation from accipiters on a game farm in the Sacramento Valley, California (Jones pers. obs.).

PROTECTIVE MEASURES INSTITUTED

1. Legal or Regulatory

The accipiters are protected by the Migratory Bird Treaty Act signed in 1972 between the United States and Mexico. Also, state laws protect each species throughout their ranges.

2. Captive Rearing

Robert Berry, Chester Springs, Pennsylvania, is apparently the first person to have bred one of the accipiters in captivity in the United States (Berry 1968, 1970, 1972). Berry began his attempts to breed goshawks in captivity in 1966. He was unsuccessful until 1970 and young were first raised in 1971. Other private individuals may have also bred goshawks, and falconers have bred Cooper's hawks. Dr. L.H. Hurrell (in Mavrogordato 1960) describes in detail the techniques used in Britain for captive breeding of the sparrow hawk, *A. nisus*. The methods outlined by Hurrell should be applicable to the North American accipiters.

3. Habitat Protection and Improvement

No habitat protection measures concerned specifically with the accipiters have been instituted. The Bureau of Land Management and Forest Service conduct yearly surveys for breeding raptors in many of the western states, ultimately aimed at the identification and protection of habitat critical to raptors. These agencies have been responsible in part for the installation of nesting/feeding platforms for raptors in Utah and the progress made with electric companies in changing the design of power poles to prevent raptor electrocutions. Patrick Benson, a doctoral candidate at Brigham Young University, is presently conducting an extensive study in 5 western states to determine the extent of electrocutions of raptors, ecological factors related to the use of powerpoles by raptors, and methods of minimizing the number of raptor electrocutions each year.

4. Reintroduction

There are no known reintroduction attempts for accipiters in the United States.

RECENT AND ONGOING RESEARCH PROJECTS

1. Christopher Asay, University of California, Davis is concluding a study of the biology of Cooper's hawks in the Sierra Nevada foothills as part of his Master's Degree program. Emphasis of the study is on nest site selection, productivity and food habits.
2. Paul Bartelt, formerly with the Black Hills National Forest, recently completed a M.S. project on nest site selection in goshawks in the Black Hills, South Dakota. Mr. Bartelt could not be contacted for further information.

3. Dr. Charles Henny, Fish and Wildlife Service, has been studying accipiters in the Pacific Northwest since 1973. The study was initiated to determine the impact of DDT spraying for tussock moth on the resident birds of prey. Primary concern is given to the collection of blood samples from wild birds and eggs for chlorinated hydrocarbon residue analysis. As a by-product of the pesticide investigation, data are being gathered on nesting habitat preferences, productivity, timing of egg laying, moult and weight loss associated with the nesting season.
4. Ms. Julie Lee, Brigham Young University, is currently conducting an M.S. study on courtship and breeding behavior of the 3 species of accipiter in an area where all 3 occur sympatrically. Emphasis of the study is to quantify courtship behavior in each species and examine interspecific similarities and differences. Nest site selection and productivity data are also being collected.
5. Helmut Mueller and Daniel Berger have been studying raptor migration at the Cedar Grove Ornithological Station in Wisconsin for the past 20 years. As a result of their extensive trapping program, data have been gathered on accipiter migration, ageing and sexing of migrant goshawks and sharp-shinned hawks and the periodic invasions of goshawks.
6. Richard Reynolds at Oregon State University completed his M.S. on the distribution, density, and productivity of accipiters in Oregon, and just recently completed his doctoral research, also on accipiters in Oregon. His research was concerned with how the accipiters partition available habitat and food resources. In 2 areas, 1 in which 2 species co-occur and the other in which all 3 species co-occur, Reynolds determined nesting density, productivity, food habits, and the pattern of habitat utilization in each of the species. In addition to providing insight into inter-specific competition between the accipiters, this study provides data on food and habitat requirements of each of the species, permitting the impact of timber harvest in Oregon on accipiters to be assessed.
7. William Shuster, U.S. Forest Service, Mancos, Colorado, is completing a study on nest site requirements of goshawks and is attempting to act as a clearing house for goshawk research in the United States. By constructing standardized data collection forms which are available to all raptor biologists, Shuster is also attempting to provide a means by which data on the habitat requirements of accipiters can be analyzed in conjunction with habitat studies on national forests. This analysis produces a map of the national forest showing the location of habitats similiar to that required by accipiters, and thereby allowing such areas to be identified and surveyed for appropriate species.

8. Kim Titus, a graduate student at University of Maryland, is studying the habitat requirements of breeding woodland raptors in western Maryland. The objective of the study is to statistically sample analytical variables of the raptor nesting sites and the habitat structure which will be analyzed to determine which specific factors are important in the nest site selection of the woodland raptors. The Cooper's and sharp-shinned hawks are among the raptors being studied. This is one of the first attempts to analyze the habitat requirements of raptors on a quantitative basis.
9. Phil Wagner, Utah Division of Wildlife Resources, is currently involved in a program of surveys for raptor species, populations, and habitats in areas selected by the U.S. Forest Service and the Bureau of Land Management. These surveys are designed to identify and protect the raptor species in areas destined for future impacts related to energy development and population growth.
10. Migration Research: Hawk Ridge, Hawk Cliff, NJRA, Cape May.

AUTHORITIES (IN ALPHABETICAL ORDER)

1. Christopher Asay (*A. cooperi*, California)
Department of Avian Sciences
University of California
Davis, California 95616

2. Paul Bartelt (*A. gentilis*, South Dakota)
former address:
Black Hills National Forest
Box 792
Custer, South Dakota 57730

3. Daniel D. Berger (*A. gentilis, striatus, cooperii*, migration)
Cedar Grove Ornithological Station
Route 1
Cedar Grove, Wisconsin 53013

4. Charles J. Henny (*A. gentilis, striatus, cooperii*, Northeast, and Pacific Northwest)
Fish and Wildlife Service
Patuxent Wildlife Research Center
480 SW Airport Road
Corvallis, Oregon 97330

5. Jerry D. McGowan (*A. gentilis*, Alaska)
former address:
Alaska Department of Fish and Game
Juneau, Alaska

6. William S. Clark (*A. gentilis, striatus, cooperii*, Eastern U.S.)
Director, Raptor Information Center
National Wildlife Federation
1412 16th St., N.W., Washington, D. C. 20036

7. Helmut C. Mueller (*A. gentilis, striatus, cooperii*, migration)
Department of Zoology and Curriculum in Ecology
University of North Carolina
Chapel Hill, North Carolina 27514

8. Joseph B. Platt (*A. striatus*, Utah)
former address:
Laboratory of Ornithology
Cornell University
Sapsucker Woods Rd.
Ithaca, New York 14850

9. Richard T. Reynolds (*A. gentilis, striatus, cooperii*, Oregon)
Oregon State University
Corvallis, Oregon 97331

10. William C. Shuster (*A. gentilis*, Colorado)
General Delivery
Mancos, Colorado 81328

11. Robert W. Storer (*A. gentilis, striatus, cooperii*, taxonomy, general biology)
University of Michigan
Museum of Zoology
Ann Arbor, Michigan

12. Noel F. R. and Helen A. Snyder (*A. gentilis, striatus, cooperii*, Southwestern U.S.)
Fish and Wildlife Service
Patuxent Wildlife Research Center
Laurel, Maryland 20811

13. Brian Walton (*A. cooperii*, California)
Coast Range Biological Research Institute
Box 2565
Santa Clara, California 95051

GOVERNMENTAL, PRIVATE AND INTERNATIONAL ORGANIZATIONS ACTIVELY INVOLVED WITH THESE SPECIES WELFARE

1. National Audubon Society
950 Third Ave.
New York, N.Y. 10022

The major objective of the National Audubon Society is to advance public understanding of the value and need for conservation of our wildlife, its habitat, and all natural resources, and the relationships of wise use of resources to human progress. National Audubon has a series of leaflets and charts on birds of prey and has concentrated its efforts for raptors in the area of education and protective legislation. NAS also funds small research projects dealing with raptors.

2. Raptor Research Foundation, Inc.
c/o Department of Zoology
Brigham Young University
Provo, Utah 84602

The Raptor Research Foundation is a non-profit organization, founded in 1967, with over 500 members in the United States, Canada, England, Europe, and South Africa. The purpose of the Foundation is to stimulate, coordinate, direct, and conduct research in the biology and management of birds of prey. The promotion of a better public understanding of the importance of birds of prey is uppermost.

3. U.S. Bureau of Land Management
Washington, D.C. 20240

The BLM administers approximately 60% of the federally-administered lands which are located primarily in the western states. These lands are managed under multiple-use principles, including outdoor recreation, fish and wildlife production, livestock grazing, timber, industrial development, watershed management, and mineral production. The BLM was responsible for the establishment of the Snake River Birds of Prey Natural Area in Idaho. Investigators from several universities and state and federal agencies study all aspects of the biology of the approximate 500 pairs of raptors of 14 species nesting within the Natural Area. The primary objective of the BLM team research on this area is to determine the extent and proximity to the Natural Area that agricultural development can be allowed without adversely affecting the wildlife and other resources of the Snake River Canyon.

4. U.S. Forest Service
Washington, D.C. 20250

The Forest Service administers the national forests and national grasslands and is responsible for the management of their resources. The Service cooperates with state and federal officials in the enforcement of game laws on the national forests and in the development and maintenance of wildlife resources. The Forest Service, in conjunction with BLM, provides funds for the cooperative raptor biologist program in Utah and district offices support regional raptor surveys throughout the western states. The Forest Service is actively involved in the identification and protection of habitat on public lands that are critical to the survival of birds of prey.

5. U.S. Fish and Wildlife Service
Washington, D.C. 20250

The Fish and Wildlife Service aids in the conservation of migratory birds, certain mammals and sport and commercial fishes. This includes the application of research findings to the development and management of a system of national wildlife refuges for migratory birds and endangered species and the acquisition and application of technical knowledge necessary for perpetuation and enhancement of fish and wildlife resources. The Fish and Wildlife Service has been responsible for a great amount of the research on the effects of pesticides on wildlife, especially birds of prey. A substantial portion of the funding for the captive breeding and reintroduction of the peregrine has come from U.S. Fish and Wildlife Service.

6. California Department of Fish and Game
1416 Ninth St.
Sacramento, California 95814

The California Department of Fish and Game is responsible for the management and use of wildlife resources in California. The Fish and Game Department has funded several studies dealing with birds of prey, and at least one (see Walton et al. 1976) concerned with accipiters. Other studies have focused on the peregrine falcon *(Falco peregrinus anatum)*, white-tailed kite *(Elanus leucurus)*, and spotted owl *(Strix occidentalis)* in California.

7. National Wildlife Federation
1416 16th. St., N.W.
Washington, D.C. 20036

The National Wildlife Federation's primary goal is to educate citizens about the need for wise use, and proper management of our natural resources. In 1976, with the aid of a grant from Exxon Corporation, National Wildlife established the Raptor Information Center in Virginia. The Center has four main goals, to identify and protect critical bald eagle habitat, to increase communication and act as a clearinghouse for information on raptors, to identify and encourage the support of priority raptor research and to monitor bald eagle and other raptor populations. In time the center will also concentrate on other species in addition to the bald eagle.

LITERATURE CITED

Alexander, M.M. 1947. Attack on ring-necked pheasant by a goshawk. Wilson Bull. 59:36.

American Ornithologists Union. 1957. Checklist of North American birds. Fifth edition.

Ammann, G.A. 1959. Sharp-tailed grouse predation by goshawk. J. Wildl. Manage. 23:110-111.

Anonymous. 1971. Much maligned hawk. Illinois Nat. Hist. Survey Rep. No. 108.

Beebe, F.L. 1974. Field studies of the Falconiformes of British Columbia. British Col. Prov. Mus., No. 17 Occasional Paper Ser. Victoria, Brit. Col.

Bent, A.C. 1937. Life histories of North American birds of prey - Part 1. U.S. Nat'l. Mus. Bull. 167. Washington, D.C.

Berger, D.D. 1957. Peculiar type of flight in Cooper's hawks. Wilson Bull. 69:110-111.

Berry, R.B. 1968. Captive breeding behavior American goshawk-- Part 1. Raptor Research News 2:58-97.

Berry, R.B. 1970. Captive breeding behavior American goshawk-- Part 2. Raptor Research News 4:18-31.

Berry, R.B. 1972. Reproduction by artificial insemination in captive American goshawks. J. Wildl. Manage. 36:1283-1288.

Bond, R.M. 1940. A Goshawk nest in the Upper Sonoran Life-Zone. Condor 42:100-103.

Bond, R.M. 1942. Development of young goshawks. Wilson Bull. 54:81-88.

Borell, A.E. 1937. Cooper's hawk eats a flammulated screech owl. Condor 39:44.

Braun, C.E., J.H. Enderson, C.J. Henny, H. Meng, and A.G. Nye, Jr.
1977. Conservation Committee Report. Falconry: Effects on raptor populations and management in North America. Wilson Bulletin. 89:360-369.

Brown, L., and D. Amadon. 1968. Eagles, hawks, and falcons of the world, Parts 1 and 2. McGraw-Hill Book Co., New York.

Clabough, E.D. 1932. Food of the pygmy owl and goshawk. Condor 35:80.

Craighead, F., and J. Craighead. 1956. Hawks, owls and wildlife. Dover Publ. Inc., New York.

Davis, M. 1948. Cooper's hawk "drowning" its prey. Auk 65:298-299.

Dixon, J.B., and R.E. Dixon. 1938. Nesting of the western goshawk in California. Condor 40:3-11.

Duncan, S. 1966. Analysis of the stomach contents of some Cooper's hawks. Auk 83:308.

Eng, R.L., and G.W. Gullion. 1962. The predation of goshawks upon ruffed grouse on the Cloquet Forest Research Center, Minnesota. Wilson Bull. 74:227-242.

Fitch, H.S., B. Glading, and V. House. 1946. Observations on Cooper's hawk nesting and predation. Calif. Fish and Game 32:144-154.

Friedman, H. 1950. The birds of North and Middle America. Part XI. U.S. Nat'l. Mus. Bull. 50. Washington, D.C.

Gabrielson, I.N., and S.G. Hewitt. 1940. The birds of Oregon. Oregon State College, Portland.

Godfrey, W.E. 1966. Birds of Canada. Nat'l. Mus. Canada Bull. No. 203, Biol. Ser. No. 73. Ottawa.

Goslow, G.E., Jr. 1971. The attack and strike of some North American raptors. Auk 88:815-827.

Grossman, M.L., and J. Hamlet. 1964. Birds of prey of the World. Clarkson N. Potter, Inc., New York.

Gruson, E.S. 1972. Words for birds: a lexicon of North American birds with biographical notes. Quadrangle Books, Inc., New York.

Hakila, R. 1969. Kanahaukan *(Accipiter gentilis)* pesimabiologiasta satakunnassa. American Reprints of the Ornith. Soc. Pari. 1968. pp. 52-54. In Finnish-English summary.

Hamerstrom, F., and F.N. Hamerstrom, Jr. 1951. Food of young raptors on the Edwin S. George Reserve. Wilson Bull 63:16-25.

Haugh, J.R. 1972. A study of hawk migration in eastern North America. Search in Agriculture 2:1-60. Cornell Univ. Agric. Exper. Stat., Ithaca, New York.

Henny, C.J., and H.W. Wight. 1972. Population ecology and environmental pollution--Red-tailed and Cooper's hawks. U.S. Fish and Wildl. Ser. Res. Rep. 2. p.

Hickey, J.J. ed. 1969. Peregrine falcon populations; their biology and decline. Univ. Wisc. Press. Madison, Wisc.

Holstein, V. 1942. Duehgen Biol. Studier over Danske Roufugle 1. Copenhagen.

Imhof, T.A. 1976. Alabama birds. Univ. Alabama Press.

Ingles, L.G. 1945. Nesting of the goshawk in Sequoia National Park. California. Condor 47:215.

Leopold, A.D. 1944. Cooper's hawk observed catching a bat. Wilson Bull. 56:116.

Linduska, J.P. 1943. Cooper's hawk carrying a nest of young gold finches. Auk 60:597.

Mailliard, J. 1908. Cooper's hawk attacking crows. Condor 10:129.

Mavrogordato, J.G. 1960. A hawk for the bush. Clarkson Potter, Inc., New York.

McGowan, J. 1975 a. Distribution, density, and productivity of goshawks in interior Alaska. Fed. Aid Wildl. Rest. Proj. Rep. W-17-3, W-17-4, W-17-5, W-17-6, Job 10.6 R.

Meng, H.K. 1959. Food habits of nesting Cooper's hawks and goshawks in New York and Pennsylvania. Wilson Bull. 71:169-174.

Mengel, R.M. 1965. Birds of Kentucky. Ornithological Monogr. No. 3. American Ornth. Union.

---------- 1967 a. Fall migration of Sharp-shinned hawks. Wilson Bull. 79:397-415.

---------- 1967 b. Some observations and comments on the periodic invasions of goshawks. Auk 84: 183-191.

---------- 1968. Sex ratios and measurements of migrant goshawks. Auk 85:431-436.

Mueller, H.S. and D.D. Berger 1970. Prey preferences in the Sharp-shinned hawk: the roles of sex, experience, and motivation. Auk 87:452-457.

Mueller, H.S., D.D. Berger, and G. Allez. 1976. Age and sex variation in the size of goshawks. Bird Banding 47:310-318.

---------- 1977. The periodic invasions of goshawks. Auk 85:652-663.

Mueller, H.C., D.D. Berger, and G. Allez. 1979. Age and sex differences in size of sharp-shinned hawks. Bird Banding 50:34-44.

Munro, J.A. 1940. Food of the Sharp-shinned hawk. Condor 42:168-169.

Nagy, A.C. 1977. Population trend indices based on 40 years of autumn counts at Hawk Mountain Sanctuary in northeastern Pennsylvania. World Conf. on Birds of Prey (ICBP) Vienna p. 243-253.

National Audubon Society. 1971. Announcing the blue list: an early warning system for birds. American Birds 25:948-949.

National Audubon Society. 1978. The blue list. American Birds. 32:870-881.

Nelson, R.W. 1968. Nest-robbing by Cooper's hawks. Auk 85:696-7.

Newton, I. 1974. Changes attributed to pesticides in the nesting success of the sparrowhawk in Britain. J. Appl. Ecol. 11:95-102.

Newton, I., and R.J.C. Blewitt. 1973. Studies of sparrowhawks. British Birds 66:271-278.

Norris, R.T. 1942. Cooper's hawk takes crippled coot. Wilson Bull. 54:250.

Platt, J.B. 1973. Habitat and time utilization of a pair of nesting Sharp-shinned hawks *(Accipiter striatus velox)*. M.S. thesis. Brigham Young Univ. Provo, Utah.

Platt, J.B. 1976. Sharp-shinned hawk nesting and nest site selection in Utah. Condor 78:102-103.

Ratcliffe, D.A. 1970. Changes attributable to pesticides in egg breakage frequency and eggshell thickness in some British birds. J. Appl. Ecol. 7:67-113.

Reynolds, R.T. 1978. Food and habitat partitioning in two groups of coexisting *Accipiters*. Ph.D. thesis. Oregon State University, Corvallis.

Schnell, J.H. 1958. Nesting hehavior and food habits of goshawks in the Sierra Nevada of California. Condor 60:377-403.

Shuster, W.C. 1977. Northern goshawk nesting densities in Montane Colorado. Western Birds 7:108-110

Snyder N.F.B., H.A. Snyder, J.L. Lincer, and R.T. Reynolds. 1973. Organochlorines, heavy metals, and the biology of North American Accipiters. Bioscience 23:300-305.

Snyder, N.F.R. and J.W. Wiley. 1976. Sexual size dimorphism in hawks and owls of North America. A.O.U. Ornithological Monograph No. 20.

Snyder, H.A. and N.F.R. Snyder. 1974. Function of eye coloration in North American accipiters. pg. 87 Condor 76:219-222.

Storer, R.W. 1955. Weight, wing area, and skeletal proportions in three Accipiters. Acta XI Congr. Internat. Ornith. 1954, 287-290.

Storer, R.W. 1966. Sexual dimorphism and food habits in three North American Accipiters. Auk 83:423-436.

Sulkava, S. 1956. Kanahuakan Pesimisaikaisesta Ravinnosta. Suomen Riista 10:44-62.

Sulkava, S. 1964. Goshawk and its feeding habits in south and central Finland. Suomen Riista 17:22-42.

Taverner, P.A. 1940. Variation in the American goshawk. Condor 42: 157-160.

Walton, B.J., L.R. Mewaldt, and E.V. Johnson. 1976. Observations on Cooper's hawk *(Accipiter cooperii)* populations in California, 1972-1975. Unpulb. manuscript. San Jose, Calif.

Wattel, J. 1973. Geographic differentiation in the genus *Accipiter*. Publications Nuttal Ornith. Club. Cambridge, Mass.

White, C.M. 1969. Population trends in Utah raptors. In J.J. Hickey, ed. Peregrine Falcon populations: their biology and decline. Univ. Wisc. Press. Madison, Wisc. p. 359-361.

---------- 1974. Current problems and techniques in raptor management and conservation. Transactions of the 39th North Amer. Wildl. and Nat. Resources Conf. Wildlife Manage. Institute. Washington, D.C. p. 301-312.

Mag Card Typing Code A18J

Fig. 6. Adult Cooper's hawks at nest. Photo by Noel and Helen Snyder.

Fig. 7. Sharp-shinned hawk feeding young. Photo by Noel and Helen Snyder.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1981—781-874/575 Region No. 8

Additional copies of Technical Notes are available from DSC, Federal Center Building 50, Denver, Colo., 80225

BLM-YA-PT-81-021-6611